Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JANUARY, 1913.

THE SHINGLE BEACH.

By E. S. GREW, M.A.

ALIKE in Europe on its north-western and western shores, and in the United States along the eastern coast of North America, as well as along the coast of Peru, the wandering sand-dune has been an object of systematic and continuous study. The shingle beach, as Professor F. W. Oliver, F.R.S. has recently pointed out in *The New Phytologist*, has received, on the other hand, comparatively little attention, probably because in the countries where attention to the sand-dune has been an economic necessity, the shingle beach is of comparatively small importance. But in Great Britain the shingle beach is not unimportant. It is part of the drift of our coasts, and as such plays a very important rôle as a defence against the wastage of the shore-line—a point which has been emphasised in the recent Report on Coast Erosion. The extent of the British shingle beaches is hardly realised, though few holiday-makers at the seaside will have found themselves at any distance from some shingle drift, and there are actually some three hundred miles of the coast of England and Wales lined by shingle. Even the most casual observation of these deposits reveals that they are not entirely stationary, and that their presence must influence the hinterland where they occur, if only to the extent of protecting golf links from the surrounding sea, as at Felixstowe, or of threatening them with curtailment as at Westward Ho! To the geologist and botanist they offer many interesting problems, both in respect of their own increase of material, and in the vegetation for which they afford either protection or a difficult foothold.

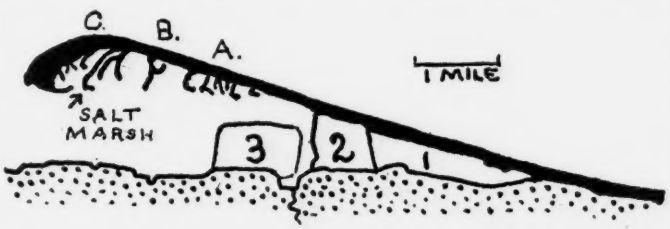

FIGURE 1. Sketch Map of the Blakeney Bank, showing systems of hooks at A, B and C. 1, 2 and 3 denote areas of marshes in the order in which they were reclaimed. The arrow above the letter S in "salt," indicates the position of the bank whose tip was turned at a right angle in 1911.

Professor Oliver's interest in shingle beaches is chiefly botanical, and in its direction is analogous to the inquiries which have been pursued by him and by the students of University College, for a number of years past in Western France. At Erquy, in Brittany, an area of salt-marsh was selected some seven years ago, and on this area has been noted the distribution of zones of vegetation; the physical characters of the soil, its salinity, and the plants appropriate to such conditions; the migration of the plants, and so on. A large number of problems have arisen out of this field of study: and some of them are repeated in different aspects in the neighbourhood of the shingle beach. But in order to define them, it is necessary to comprehend first the methods of formation of the beach; and to this

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question Professor Oliver, to whose article we are indebted for the information which is to follow, gives preliminary attention.

Shingle banks arise when suitable materials from the waste of the shore find their way into the currents which run along the coast. In these shallow waters the shingle is always on the move owing to the action of the waves, and is kept steadily moving in the direction of the current. Heavy seas, and on-shore gales pile the shingle up above high-water mark and thus form the banks or beaches. These are of three types:—

(1) THE FRINGING TYPE.—This is the simplest case, the shingle being directed by the shore current and forming a strip in contact with the land on top of the sand beach. There are many examples of this kind of shingle beach in Sussex.

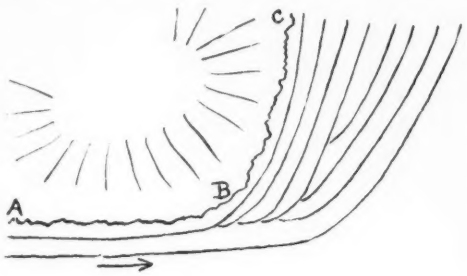

FIGURE 2. Apposition type of Shingle Bank. A, B, C, indicate a point of land; the arrow marks the direction of coastal drift; the successive shingle banks lie to the right of the figure; modified from F. Drew.

(2) THE SHINGLE SPIT.—Suppose now that the coast line suddenly changes its direction, and turns inwards, while the current running along it still goes shooting past the point of deflection. The drifted shingle accumulates along the line of the current to form a bank or causeway, often reaching a length of several miles. This type is attached to the shore at the point where the current leaves it, and then runs straight on or with a gentle curvature towards its growing distant end. It generally turns inward. Examples are Hurst Castle Bank and Blakeney Bank.

(3) THE BAR.—When a shingle spit of this kind continually stretching and growing touches land again it forms a bar. Professor Oliver notes that the Chesil Beach which is so conspicuous a feature at the Isle of Portland (its eastern extremity) seems at first sight to belong to this category; but its exact status is still a matter of discussion.

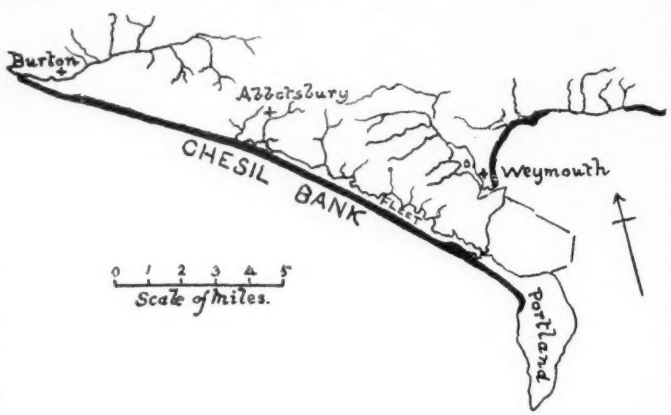

FIGURE 3. Sketch Map of the Chesil Bank (after Bristow and Whitaker) to show the relations of Bank, Mainland and Fleet. Shingle is drawn thick black.

(4) THE APPOSITION TYPE.—Sometimes the pushing current by changing its direction or force has not enough strength to carry the shingle to the end of the bank; or else the end of the bank has been hooked inwards so far that the current cannot reach it. In these cases the spit cannot lengthen and the additions of shingle are merely dropped by the current on the flank of the forming bank. These additions may be lifted above the top of the bank by a high tide or gale. In this way a succession of more or less parallel banks may be thrown up one behind another, with the result that very extensive areas of shingle are produced.

The outstanding example of this type is Dungeness (see Figure 2).

To return to the Shingle Spit. As already explained, the point at which the spit leaves the shore is a salient angle of the mainland. The axis of the bank runs along the line of the current and generally presents a gentle convex curve to the sea. As a rule this type runs at some distance from the shore line, the protected area between bank and shore being occupied by salt marshes subject to the tides. These salt marshes are practically a kind of littoral shelf on the edge of which the shingle rests: and they often offer facilities for reclamation. The spits which protect them most often pursue their course from the point where they are attracted to the mainland, without any alteration in character beyond an occasional narrowing or widening. The Aldeburgh bank in Suffolk goes right on to its apex without alteration.

But usually, towards the apex, there appears a marked landward deflection in the form of a hook: and frequently several hooks are present in close proximity (Hurst Castle, Hamstead, Dover): while, as at Blakeney, there are occasionally extremely complex systems of hooks (see Figure 1). "One of the hooks at Blakeney has in recent years become exposed to gales from the north-west in consequence of the wasting of the top of the main bank which formerly masked it. At Easter, 1911, a succession of heavy gales from this quarter removed the terminal portion of this hook and deposited the eroded material as a new bank one hundred and forty feet long, fifty feet wide, and over six feet high, at right angles to the old hook, on its lee side" (see Figure 5). Professor Oliver concludes that a shingle spit has quite definite, successive phases. There is the phase of youth in

which growth is mainly in length; and this is followed by a more or less prolonged phase of hook formation, when the action of the current begins to yield its domination to the activity of the gale. Blakeney Bank illustrates in its finger-like stretch of two miles the formation of multiple hooks on the grand scale (see Figure 6); and here there seems to be evidence of the oscillation of conditions in which the current and the wave have alternately triumphed.

FIGURE 4. Chesil Bank looking S.E. from a point opposite Burton Mere, near Burton Bradstock.

The Chesil Bank, which furnishes the most considerable and imposing accumulation of shingle in the British Isles, forms a problem by itself. It stretches fifteen miles as a continuous strip from Burton Bradstock to Portland (see Figure 3). The height of its crest above high water mark ranges from twenty to thirty feet, while its width averages five hundred feet. The roar of a south-western gale on its pebbles at the Isle of Portland is a sound which lingers in the ears of anyone who has ever slept, or lain awake, during a night there. From Burton Bradstock to Abbotsbury (six miles) the Chesil Bank fringes the mainland (see Figure 4); from this point to Portland the bank is separated from the land by a shallow estuary, the Fleet, or Backwater, about eight miles long, and sometimes half a mile in width. As already observed the Chesil Beach might be regarded possibly as a Spit or a Bar. Quite recently it has been thought to have developed not as a spit but as a fringing beach behind which the land has retreated in consequence of sub-aërial denudation. The Fleet or Backwater would thus have been excavated behind the bank. Professor Oliver remarks on a peculiarity of the Chesil Bank, confirmatory of this theory, which is that the bank presents not a convex but a concave front to the sea. There are many other problems of the shingle bank, especially the movements of its hooks, and the percolation of water through it—for which further reference may be sought in Professor Oliver's original work; and there, too, will be found an outline of the development of the flora of the beach. One of the outstanding mysteries of the shingle spit is its water supply and the plants which are nourished by it. The lower parts of the spit are tenanted by plants which do not need salt. Above them there is a residuum of plants intolerant of salt. Where do they obtain the water to nourish them? Such water exists, and is indeed astonishingly copious, in the interstices of the shingle. In last year's burning summer the upper vegetation of shingle spits prospered, and the sheep fed on it—especially on the Chesil Bank. The source of this water is possibly to be attributed to the formation of internal dew in the shingle.

From a Photograph by *E. J. Salisbury, July, 1911.*

FIGURE 5. A new hook at Blakeney Point, formed in March-April, 1911, on the bank marked with an arrow in Figure 1.

FIGURE 6. Inner edge of Blakeney Main Shingle Bank encroaching on the "Marains," looking west. The bushes are *Suaeda fruticosa*.

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THE PSYCHOLOGY OF TELESCOPIC VISION.

By W. ALFRED PARR.

LITTLE BUTTERCUP, of "H.M.S. 'Pinafore'" fame, gave vent to a profound piece of general philosophy when she assured Captain Corcoran, of that vessel, that "Things are seldom what they seem." Now, although this is a fundamental verity familiar enough to us all, we are occasionally reminded of the peculiar virtue underlying this Gilbertian dictum in quite an unexpected manner when looking through a telescope. If we regard a far-off landscape through a powerful telescope, fitted with an erecting day eyepiece, we soon become aware of the fact that any distant cottages or houses which our landscape may contain appear to us strangely out of drawing. More especially is this the case with such houses as happen to have their longest sides parallel to our line of sight, so that we look along them, as it were, instead of squarely at them. We shall find, on examining these closely, that, instead of presenting the ordinary aspect we are accustomed to associate with the rules of foreshortening, they boldly bid defiance to all our ideas of perspective and stand out at us in a manner which is truly astonishing. And, if we recall the statement we so often hear, that the function of a telescope is to make a far-off object appear as if it were only at a short distance from us, our astonishment will be the greater, since no houses within our previous experience wear such a curiously distorted guise as these.

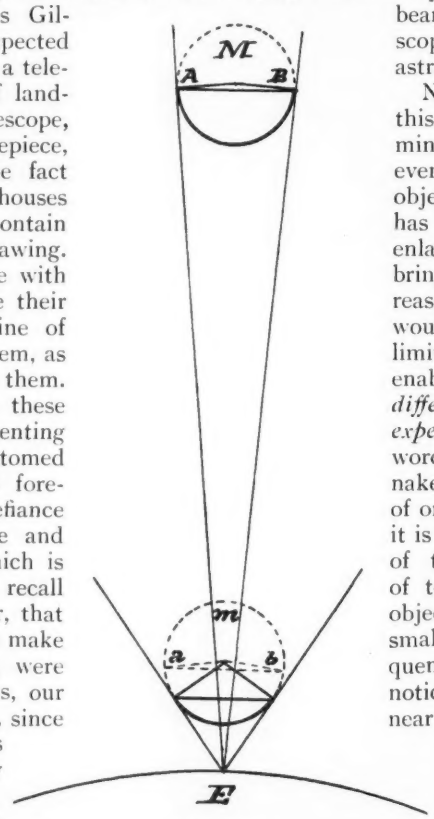

FIGURE 7.

It was claimed by the promoters of the giant telescope, which was intended to form the *clou* of the Paris Exhibition in 1900, that the moon was to be brought by this instrument literally within our grasp!—if we could reach a metre—and popular accounts of the great Yerkes telescope affirmed that it would make our satellite appear just as it would be seen with the naked eye if it were suspended but sixty miles over our heads. Such irresponsible statements as these are not only in the highest degree misleading in themselves, as I ventured to point out some years ago in a letter to the British Astronomical Association,* but, even supposing the exaggerated claims, just quoted, as to the "approximating" power of a great telescope to be possible of realization, it can still be shown that the telescopic image of an object is vastly different from the actual aspect that object would present if viewed by the naked eye at the same apparent distance. This somewhat ignored fact is a distinct and important feature of telescopic vision; for it has an interesting bearing on our interpretation of telescopic pictures in general, be they astronomical or terrestrial.

Now, our surest way of keeping this peculiar action of the telescope in mind is to remember that, far from even apparently bringing distant objects nearer, as the popular claim has it, the telescope in reality merely enlarges the naked-eye view. It brings to our notice objects which, by reason of their great distance from us, would otherwise remain beyond the limits of critical vision, and thus enables us to see them *under conditions different from those under which our experience is usually gained.* In other words, the telescopic image and the naked-eye image are essentially copies of one another on varying scales, and it is only in our different interpretation of these scales that the peculiarity of telescopic vision resides. Distant objects are habitually seen under a small visual angle, and they consequently fail to excite our critical notice in the same degree as do near objects which are seen under a larger visual angle. But when the telescope comes to our aid and enlarges our naked-eye view for us, we are apt to fall into error, and, if we do not in reality consider ourselves suddenly confronted with an actually nearer object, we, at any rate, regard that object with all the inferences which the enlarged image conjures up in our minds. We mentally endow the magnified retinal image with all the attributes which an object of its apparent size would possess, and fancy our larger picture also nearer, in conformity with our past association of largeness and nearness. We must remember, however, that in looking through a telescope we become aware of conditions which are foreign to our usual experience, and of which, but for the instrument's power, we should have remained in ignorance.

Thus, to consider for a moment the simple

* See *Journal Brit. Astro. Assoc.*, Vol. IX, p. 271.

geometrical aspect of the question in its relation to astronomy, as illustrated in Figure 7, where the circle M may be allowed to represent the moon, it is clear that the portions of the lunar surface at A and B are seen under what we can only describe as unnatural conditions when viewed telescopically from E, since they would remain wholly invisible to an observer capable of inspecting the moon at close quarters. Now, when we apply a powerful telescope and bring the moon apparently nearer, as at *m*, the portions of the lunar limb at A and B remain visible, instead of lying beyond our sight at *a* and *b*, as the figure shows they would do, if we were in reality as near the moon as the telescope apparently brings us. It follows that the lunar features near the limb are always seen under a certain amount of distortion, which decreases as we approach the centre of the disc; but so familiar has this telescopic deformation become, that the eye practically ignores it, and accepts the illusion of an actually approximated moon.

FIGURE 8.

The Villa Fabbricotti, Florence. taken with a telephoto lens, magnifying 15 diameters, at a distance of $\frac{1}{4}$ mile.

Though a telescope magnifying one thousand times is said to theoretically bring the moon within a distance of only two hundred and forty miles, we must bear in mind that an observer, who might be supposed to regard our satellite at this distance with the naked eye, would have a very different scene presented to his view from that with which telescopic astronomy has made him familiar. Not only would there be the geometrical reduction of the visible area noticed above, but that area itself, being viewed under altered visual conditions, would wear a different aspect. The astronomer's eyes, in fact, have become vitiated, so to speak, by this peculiar action of the telescope; much as the musician complains that his ears have become corrupted by accepting the artificial intervals brought into universal musical practice by the adoption of the system of tuning by equal temperament.

But if the eye, in accepting the illusion of an approximated moon, has learned to tolerate selenographical distortion, since it is solely under telescopic conditions that lunar detail has been brought to our notice, the case is quite another one when we contemplate distant terrestrial scenery through the telescope. Here all is familiar, and the same, or at least similar, objects have been originally studied by us at close quarters, so that when we expect to witness the anticipated approximating effect of our telescope we stand amazed at the curious spectacle offered to our view. In Figure 8, for instance, we notice to some extent the singular out-of-drawing effect of the ordinary telephotograph. The building illustrated has an interest of its own, being the Villa Fabbricotti, just outside the gates of Florence, where Queen Victoria resided in the spring of 1894; while the photograph, which was taken with a telephoto lens magnifying fifteen diameters at a distance of a little over a quarter of a mile, shows, especially on the right hand side, in the seeming divergence of the lines along the top of the machicolated tower and the roof of the villa, that peculiar effect of telescopic

FIGURE 9.

View of Florence, taken from the Palazzo Vecchio, and showing the hills of Fiesole in the background.

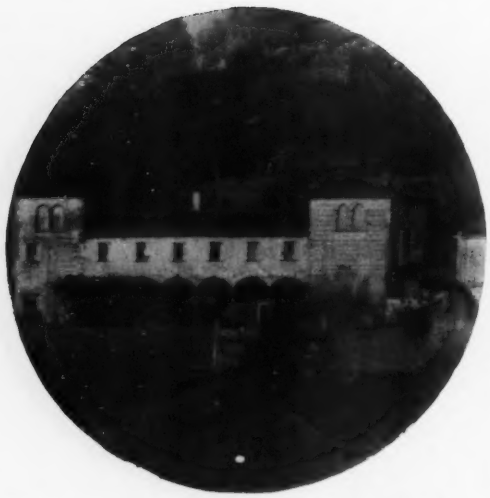

FIGURE 10. The Villa degli Angeli at Fiesole, as photographed from Florence through a telescope magnifying 40 diameters.

vision which is brought out more vividly in a powerful instrument.

In order to exhibit this peculiarity to its fullest extent, I instituted some experiments in the photography of distant buildings by means of an ordinary Kodak camera, from which the lens had been previously removed, attached to a three-inch refracting telescope, fitted with an eyepiece magnifying some forty diameters; and although, as might be expected from the non-photographic character of the usual telescopic objective, the resulting pictures leave a good deal to be desired as regards strength and clearness, they are sufficiently distinct to show the characteristic feature of telescopic vision in a very striking manner. Taking advantage, therefore, of the extensive view commanded from the terrace of the Palazzo Vecchio near the centre of Florence, I first took an ordinary photograph of the group of hills, some three miles distant, upon which is situated the ancient town of Fiesole, and then, combining camera and telescope in the manner described, photographed separately some of the more conspicuous villas embraced in the general view. Thus Figure 9 may be regarded as representing the naked-eye view of Fiesole as seen from Florence*, while Figures 10, 11 and 12 represent the telescopic images of the villas just discernible, and marked respectively with one, two, and three dots, in Figure 9. Of these, Figure 12, which shows the corner and foreshortened side of the villa marked with three dots in the middle-distance of Figure 9, offers undoubtedly the most violent shock to our ideas of rational perspective, and may for this reason be taken as a fitting object lesson in connection with our present topic. The distance from the observer—about one and a half miles—and the position of the house with regard to his line of sight, as well as the magnification employed, all conspire in this case to produce a most interesting result; and so odd, in fact, was the aspect which this particular building presented in the telescope that it was known as the *Villa Storta*, or crooked villa, by those who thus beheld it for the first time. But the crookedness is, after all, merely psychological, for the photograph serves as a singularly apposite illustration of what Professor James Sully calls interpretative illusion.†

Now, as the perception of magnitude is closely connected with that of distance, and the building depicted is sufficiently removed from the observer for its near and far ends to be seen under practically the same visual angle, our ordinary ideas of perspective are disturbed. We are, in fact, by virtue of the magnifying power of the telescope, able to contemplate this building under conditions foreign to those under which our experience has been hitherto gained, so that the lines of roof and first story, instead of converging as they recede from us, as would certainly be the case if the building were actually as near

FIGURE 11. The Villa Torrosa, Fiesole, as photographed from Florence through a telescope.

FIGURE 12. The Villa Ventaglio, as photographed through a telescope.

* The two towers in the picture, which, as here reproduced, is necessarily seen on a reduced scale, are (from left to right) those of the Badia and the Bargello.

† *Illusions, A Psychological Study*, by James Sully, 1895 (Vol. XXXIV of the International Scientific Series).

the spectator as the telescope apparently brings it, are here found to be practically parallel, since their *vanishing point*, as the draughtsman expresses it, is in this case extremely remote. We are thus confronted with a condition of things which in the ordinary way of life would be beyond the critical limit of vision. But now comes an interesting psychological moment; for the mind insists upon continuing its usual operation even under the present unusual circumstances. Knowing the two ends of a house to be of equal size, we make a habit of mentally enlarging the reduced image of the distant end to fit the near end; and here, where there is practically no dissimilarity between the retinal pictures of the two ends, we persist in mentally enlarging the distant end, with the curious result that the lines of the house appear actually to *diverge* as they recede from us. But that this astonishing effect is nothing but a psychological illusion, anyone can easily prove for himself by simply holding the picture in such a position that the eye can glance obliquely down the seemingly divergent lines, when he will at once become aware that they are practically parallel; the actually existing, but extremely slight, *convergence* towards the distant end being quite inappreciable.

To a lesser degree the same effect may be traced in the appropriate portions of the other telescopic pictures, notably in the right sides of the Villa degli Angeli (see Figure 10) and the Villa Torrosa (see Figure 11), while it is instructive to note how persistently the illusion of divergent receding lines reasserts itself in each of the photographs, although we may convince ourselves with compasses and ruler that geometrical orthodoxy in reality reigns supreme.

This is a striking confirmation of the truth that the same personality enters into the examination of a photograph which is known to exist in the actual observation of nature, and the interesting fact is once more brought home to us in the study of such unusual phenomena as the present, that things are apt to change their seemings to suit our preconceived opinions concerning them; for our judgment is to a great extent a process of semi-conscious inference based upon a variety of circumstances drawn from our past experience and sense of association. We may, indeed, reverse the old saying in such a case as this and claim that, here at least, Believing is Seeing.

A HEN OSTRICH WITH PLUMAGE OF A COCK.

By F. W. FITZSIMONS, F.Z.S., F.R.M.S.

(Director of the Port Elizabeth Museum.)

IN April, three years ago, at a caponizing demonstration at Graaff Reinet, Cape Province, at which there were over forty farmers and townsmen present, Veterinary Surgeon Elley removed the ovaries from three hen ostriches. The hens were each four years of age at the time. Shortly after the operation the three hens began to assume the black body plumage of the adult cock bird, and from the characteristic drab colour of the feathers of a female, these feathers turned jet black and became glossy as in the male. Another remarkable thing happened. The wing and tail feathers also changed, and became so like those of the cock bird that feather experts, to whom they were shewn, declared them to be the typical feathers of a cock ostrich.

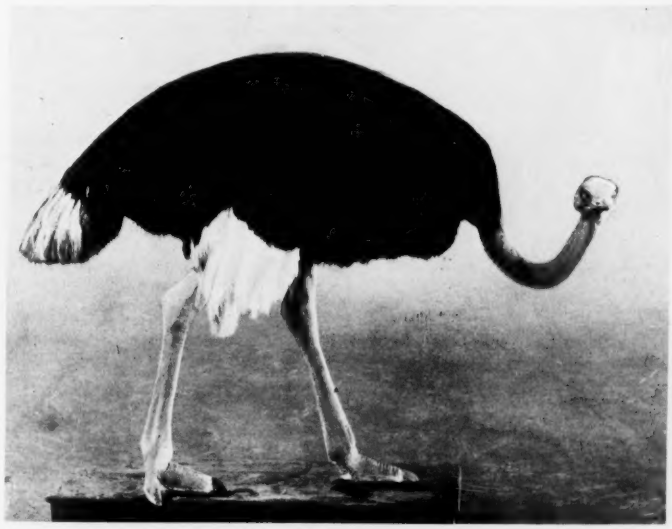

FIGURE 13. A Hen Ostrich with the plumage of a Cock.

These hen ostriches belong to Mr. W. Rubige, a well-known Graaff Reinet farmer, and he kindly consented to have one of them chloroformed and presented to the Port Elizabeth museum for exhibition. The bird was sent to us in the flesh, and I had the satisfaction of making a personal examination to make quite sure it was a female. There are many, no doubt, who will be sceptical, but I can assure them there is absolutely no doubt about the bird being a female. In the accompanying photograph, the hen bird is shewn after it was mounted by my taxidermist.

It will thus be seen that the removal of the ovaries in these three instances caused remarkable constitutional changes. Hitherto we have supposed that the ovaries, as their name implies, were concerned only in the production of ova or eggs.

MODERN CONCEPTIONS OF CELL-STRUCTURE AND FUNCTION.

By HAROLD A. HAIG, M.B., LOND.; M.R.C.S., ENG.

(Lecturer in Histology and Embryology, University College, Cardiff.)

NOWADAYS, the study of the complex problems dealing with cell-organisation and function is becoming more and more important and in certain branches of biology, notably pathology and bacteriology, is one which becomes intimately connected with abnormal processes in the cell; these processes are only to be correctly interpreted when the inner workings of the *normal* cell are understood, and in but few instances can it be said that the normal phenomena are fully explained. In the present article it will be my object to place before the reader a few of the more modern ideas with regard to the structure and function of the cell, and to try and explain the reasons why a normal cell-unit when subjected to morbid influences should have its life-cycle so profoundly altered as to produce, either in the individual cell or cell-aggregate, signs of obvious functional derangement.

At the outset, it should be remembered that a typical *cell*, whether animal or vegetable, is made up structurally of at least four parts (see Figure 14) *viz.*:—

a. The cytoplasm.

b. The nucleus, an oval or spheroidal body situated somewhere in the cytoplasm.

c. The plastids, small living structures concerned with the manufacture of various foods in the cell.

d. The vacuoles; these are spaces filled with fluid, usually a watery solution of salts, certain proteins, organic acids, sugars, and so on (cell-sap).

The cytoplasm, nucleus, and plastids constitute the protoplasmic portions of the living cell or *protoplast*: the cytoplasm is often, especially in vegetable cells, surrounded by a firm *cell-membrane* composed either of carbohydrate material (cellulose) or of a rather firmer protoplasmic substance derived from the outer part of the cytoplasm (ectoplasm). The animal cell is, however, rarely enclosed by a complete cell-membrane, and this membrane, when present, is never composed of cellulose.

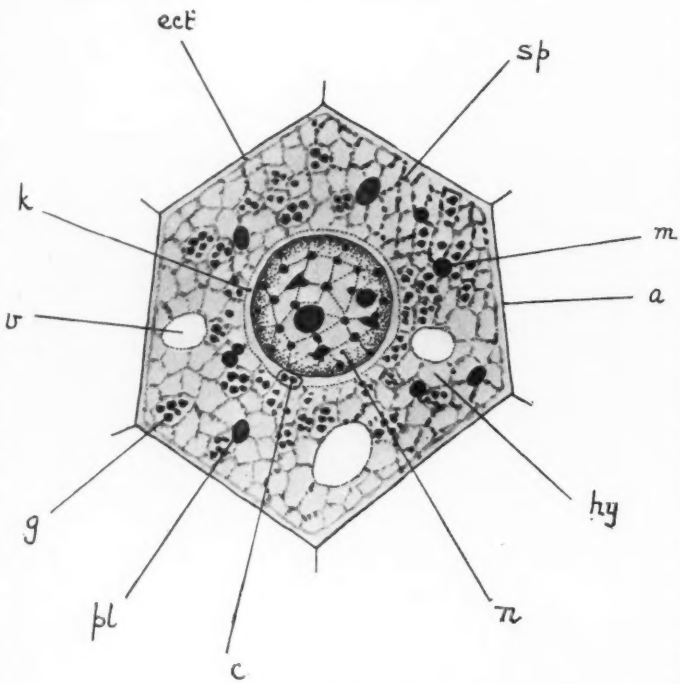

FIGURE 14.

Diagram of a typical cell (stained with nuclear and plasmic stains).

a. Cell wall: not always present; *ect*. Ectoplasmic layer of cytoplasm: this is often present in plant cells; *sp*. Spongioplasmic network of cytoplasm, upon which minute granules or "microsomata" are to be seen; *hy*. Hyaloplasm; *g*. Granules, either of the nature of zymogen-granules or Altmann's (see text); *k*. Vacuoles; *pl*. Plastids; *m*. Metaplasm granules (starch, protein, etc.); *k*. Kinoplasm; *n*. Nucleus showing (*i*) clear nuclear plasm (*ii*) Linin network (*iii*) Chromatin-granules and Karyosomes (*iv*) Plasmosomes or nucleoli, the whole surrounded by the nuclear membrane. *c*. The centrosome (doubled).

In its elementary structural details, as put forward above, there is very little difference between the plant and the animal cell; but in ultimate function there are often very marked differences, the most well known of these being perhaps those connected with the presence in the plant cell of the *chloroplastids*, the small oval protoplasmic structures which contain the green pigment *chlorophyll*. The chloroplastids are thus able, by virtue of their possession of this pigment, to utilise a portion of the radiant energy of white light, and to turn this energy to account in furthering the decomposition of carbon dioxide and water by the plastid, the ultimate result being the formation, by means of *chemosynthetic* reactions, of some form of *sugar* (probably dextrose). The animal cell rarely, if ever, possesses chlorophyll; and in those instances where chlorophyll-containing bodies are found in an animal cell (Hydra, Euglena and other Flagellata), these almost always turn out to be members of the Volvocaceae which appear to be living in symbiotic connection with the animal cell. This being so, the animal cell is not able by

its own efforts to make use of the carbon dioxide existing in the surrounding medium (atmosphere or water), and in the majority of instances receives its raw food materials in the form of complex carbohydrate and protein compounds, the former of which have already been built up for it by the vegetable cell; the latter, perhaps by the vegetable cell, but in many cases by other animal organisms. The above elementary physiological processes in a cell serve to partially distinguish between the character of the functions of vegetable and animal protoplasm, although, as was pointed out, there may be no structural distinction; moreover, the explanation of such variation in function must be looked for, not in structural distinctions, but in the gradual changes taking place during *evolution* from the plant to the animal type,* changes, which, although undoubtedly existent, still remain more or less unexplained.

With regard to the structure of the several parts of the cell noted above, it will perhaps be best to take these in order, and consider some of the hypotheses which have been advanced with respect to their ultimate physical constitution. I do not propose to go into the consideration of the chemical composition of protoplasm, as this somewhat undecided question is one which is likely to lead the reader too far afield, and, moreover, might have the effect of confusing his mind as to the object of this article, *viz.*, the conception from a purely biological point of view of cell-structure and function.

(*a*) STRUCTURE OF CYTOPLASM.

Early conjectures as to the internal structure of cell-protoplasm were not of such a nature as to enable much criticism, seeing that the methods then in use for "fixing" cells and for staining their constituent parts were hardly adequate to bring out many structural details; moreover, the microscope, at the period when Hugo von Mohl made his interesting discovery of the "primordial utricle" in vegetable cells, was not the high-class instrument it is nowadays. Nevertheless, many interesting and accurate observations were made at that time, more especially in connection with the composition and structure of the cell-wall.†

Protoplasm was at that period looked upon as being quite homogeneous in physical constitution, and it is only fair to state that there are many nowadays who have come back to this view; it was, however, soon found that such a conception must be modified, in that, in many living cells, notably *Amoeba*, *Aethalium*, and numerous plant-cells, the main cytoplasm was found to be made up of a clear outer part, the *ectoplasm*, and an inner portion which was granular and in some cases reticular, the *endoplasm*, the latter enclosing as a rule one or more vacuoles filled with fluid contents. This distinction into outer and inner portions is not to be made in every cell, since very young cells of embryonic tissues appear during life to be almost entirely, if not quite, filled with a mass of homogeneous living substance, in which the nucleus and some granular structures are suspended.

Later observers, notably Nägeli, Schwann, Flemming, Cohnheim, Bütschli, Heidenhain, and many others have attempted to explain the structure brought out by "fixing" living cells rapidly by means of such substances as osmic acid, chromosmium acetic acid, alcohol-formalin-acetic acid, and others, upon the lines that the appearances produced by these reägents represent the true living structure of the cell-protoplasm; some of these appearances are, no doubt, correct representations—as, for instance, the fixation of the vacuoles in the cytoplasm, and the chromatin-network in the nucleus; but others are at least of doubtful significance, and the present-day cytologist has to guard very carefully against mistaking an "artefact" in the cell for the true structure. One conception as to cytoplasmic structure which, although open to considerable criticism, is, nevertheless, provisionally accepted by many workers at the subject, is that which gives to it a reticular basis or ground-substance of fibrils, the so-called *spongioplasm*, in the meshes of which a more fluid portion, homogeneous in appearance, the *hyaloplasm*, exists; it cannot be denied that even in the living cell, in some instances, a fibrillated appearance is to be seen in the cytoplasm, and this persists and becomes more pronounced after fixation.‡

Another hypothesis which at one time appeared likely to gain ground was that put forward by Bütschli, who considered that cytoplasm might possess an alveolar or froth-like structure, the spaces in this being filled with liquid; certainly the egg-cells of certain animals, notably *Ascaris* and *Asterias*, possess a cytoplasm which suggests strongly the alveolar structure, and cells of the nephridia of *Lumbricus* and the Leech show a typical froth-like appearance. But on the other hand there are many cells the cytoplasm of which conforms more closely to the reticular type; and in the case of certain large nerve-cells in the spinal cord and brain it has been shown by Cajal and Bielchowski that a very fine system of fibrils, the so-called *neurofibrils*, can be brought into evidence by a process of treatment with nitrate of silver and subsequent development. These *neurofibrils* were also shown to extend into the axis-cylinder process (axon) of the nerve-cell, as well as into the processes known as dendrons.

The *granules* seen in protoplasm are nowadays considered to be very important structural elements,

* It has been shewn that the Flagellata probably represent a sort of connecting link between the vegetable and the animal kingdoms.

† See "The Vegetable Cell," by Hugo von Mohl, translated by Professor Henfrey. 1854.

‡ Mention must be made, in this connection, of the experiments carried out by Hardy with colloids (such as various mixtures of gelatine and water) which pointed to the similarity of cytoplasm in physical constitution, to the "solid within a liquid" type of gelatine hydrosol.

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and many of them are undoubtedly of cytoplasmic origin (microsomata); a few of them are capable of taking on certain stains, such as "neutral red" in the living cell prior to any fixation, and after fixation at least four types of granule may be distinguished according to the manner in which these structures stain. Thus there are to be found the so-called *neutrophilic* granules (see Figure 15) staining with neutral dyes (neutral red), the *oxyphilic* type (see Figure 16) staining with acid dyes such as eosin and acid fuchsin, the *basiphilic* granules (see Figure 17), which stain deeply with alkaline stains such as methylene blue; and there are at times to be found *amphophilic* granules staining with either an acid or a basic dye. Many of the larger granules seen in the cytoplasm are, of course, to be placed amongst the category of "metaplasm," these being the various granules of reserve food (starch, protein, and so on), and the plastids are naturally quite distinct from the small elementary structures noted above.

FIGURE 15.

A polymorphonuclear neutrophile leucocyte from human blood, showing minute neutrophilic granules (represented too large in figure).

The *Microsomata** mentioned above usually exist upon the reticulum of spongioplasm (where this can be definitely stated to be present) and stain as a rule with the acid dyes; the other granules described are usually small rounded bodies, varying in size from a quite distinct particle to a fine granular appearance in the cell, the ultimate granules being very indistinct (neutrophile type in certain leucocytes). Such granules are, as a rule, found scattered throughout the cell without any definite relation to the spongioplasm network.

Another type of granule remains to be mentioned, and that is the one first described by Altmann (Altmann's granules); these, which stain with acid stains (acid fuchsin) after special treatment with other reägents, are found in all animal and plant cells with the exception of the ovum, the male germ-cell, and cells forming cancerous growths. They are assumed to possess an important rôle in the cell economy; but the precise nature of their function is, I believe, still *sub judice*.

Some of the granules mentioned above are looked upon as possessing the capacity of manufacturing *enzymes* in the cell, or may be the actual precursors of the enzyme themselves; the granules seen in the secreting cells of many glands, both in animals and plants, are known to be *zymogens* and these granules may be seen readily in the living cell. But the function of many of the types noted is by no means settled, and the study of them is perhaps one of the most important branches of cytological work which is being carried out at the present time in biological laboratories.

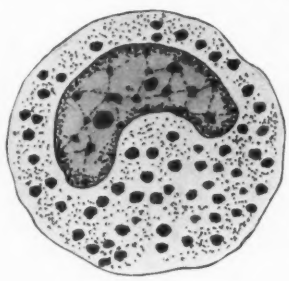

FIGURE 16.

A coarsely granular oxyphile leucocyte from human blood.

(*b*) STRUCTURE OF THE NUCLEUS.

I have had occasion before in this magazine to describe the structure of the nucleus in connection with the mechanism of nuclear division,† and since writing the article in which this occurred have made further observations upon nuclear structure. The results have gone to confirm the generally-accepted description of the constitution of the nucleus, *viz.*, that this body is to be looked upon as a spheroidal space limited externally by a firm membrane formed, in all probability, of altered hyaloplasm (kinoplasm), this space being filled with clear nucleohyaloplasm, suspended in which latter is a network of *linin*, and in the resting nucleus the granules of chromatin are arranged upon this network at somewhat irregular intervals (see Figure 18). With regard to the presence of a nuclear membrane, a somewhat controversial point, the fact that the nucleus moves bodily along in the endoplasm during the phenomenon of "rotation" in the living assimilating cells of plants (*Vallisneria*, *Elodea*, and so on) without any alteration of shape, seems to point to the possession of an external firmer delimiting pellicle, quite distinct from the cytoplasm of the cell. The nucleoli (plasmosomes) appear also to have an external skin, within which the fluid parts of these bodies is contained.

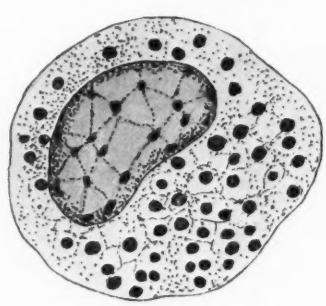

FIGURE 17.

A coarsely granular basiphile leucocyte from human blood (very rarely found.)

[NOTE.—This and the previous two figures are from coloured diagrammatic drawings from a blood film made by the author.]

Further research by cytologists has pointed to the presence of fine fibrils passing from nucleus to nucleus in adjacent protoplasts; it will be remembered that distinct intercytoplasmic connecting bridles have long been demonstrated passing between adjacent cells (Gardiner and others: see Figure 19)

*The Microsomata are, it appears, chiefly concerned in the production of the cell-wall in plant-cells, a process akin secretion going on, which results in the deposition of cellulose.

†See "KNOWLEDGE AND SCIENTIFIC NEWS," August–September, 1909.

and the demonstration of an internuclear connection is certainly an interesting point.

It is noteworthy that in a few instances the chromatin constituent of the nucleus takes, in place of separate granules, the form of a so-called "permanent spireme" suspended in the nuclear plasm; the chromatin in these cases takes the shape of small discs placed end to end quite close together. The permanent spireme is best seen in the cells of the salivary gland of the larva of *Chironomus*. At times, also, the chromatin granules become split into two and even in the resting nucleus a spireme may be seen made up of two parallel bands of granules, an arrangement which is obviously of value when karyokinesis takes place, since the earlier stages of the prophase are eliminated.

With regard to the changes taking place in the structure of the nucleus during mitosis, reference may be made to the article mentioned above (see footnote on page 10); these changes indicate, in the main, an increase in the chromatin, a relative decrease in the para-chromatin (nucleolar material) and loss of the nuclear membrane. The latter change is important since, if the membrane persisted, the movements of the chromosomes to opposite poles of the cell would be prevented; this, then, is further evidence of the presence of a membrane in the resting condition of the nucleus. [The question of the centrosome is one more directly connected with nuclear division, and will not be gone into here.]

(*c*) Structure of the Plastids; Outline of their Function.

These small bodies, many of which contain pigment (chromoplasts) and others being colourless (leucoplasts) have a structure which appears to repeat in some respects that of the nucleus; but there is no nuclein constituent in them comparable to the chromatin of the nucleus. In the main, each plastid appears to possess an outer membrane, and internally, either a clear fluid part, or, as some observers state, a groundwork of fibrils (spongioplasm) in the meshes of which is a clear, more fluid portion; it is the latter which has dissolved or suspended in it the pigment, when this is present (chlorophyll, xanthophyll, carotin, and so on).

In many cases the plastids contain starch or oil in their substance, this being evidence of the secretory function of these bodies, and it appears probable that these stored substances are formed by an actual breaking down of the protoplasm of the plastid with a subsequent re-construction of the starch or oil. The function of the pigment chlorophyll has already been touched upon (see page 8), but it should be borne in mind that in the colourless plastids (leucoplasts) found in the cortical cells of subterranean stem-structures and roots, the starch is formed from the circulating sugar brought to the cell without the intervention of the photosynthetic process, the necessary energy for the secretory reactions being derived from other sources than white light.

Fats and oils occurring in the so-called *elaioplasts* are formed in much the same manner; but, of course, oxidation is at times incomplete and a hydro-carbon is sometimes formed in place of a carbohydrate.

(*d*) The Vacuoles.

The modern conception of the *vacuole* has been elaborated considerably of late years; in fact, ever since the importance of the biophysical phenomenon of *osmosis* in the cell was recognised. The fluid contents of the vacuole in the plant cell always possess one or more of the *organic acids* in an amount sufficient to set up osmotic currents between the fluid in the vacuole and the medium surrounding the cell, with the result that in many instances water and salts are drawn into the vacuole according to the needs of the protoplast.

Observations upon the origin and growth of the vacuole have determined the interesting fact that directly a vacuole becomes visible, the fluid contents become surrounded by an extremely delicate pellicle of ectoplasm (hyaloplasm), and many investigators have looked upon the formation of the vacuole as being akin to that of a plastid—vacuoles being sometimes known as *tonoplasts* (De Vries) in that they govern the relative turgidity of a cell. The pellicle of ectoplasm of the vacuole, the endoplasm, and the layer of outer ectoplasm of the protoplast together form a membrane, which, in the opinion of most biologists nowadays, is of great importance in the process of absorption by the cell of water and salts in solution; the so-called "selective capacity" of a root-hair, for instance, being largely due to the presence of the three living layers surrounding the vacuoles. The physical laws governing osmosis naturally come into play during the process of absorption, and the amount of saline constituents entering the cell depends largely upon the relative "osmotic pressures" exerted, on the one hand, by the osmotically active substances (organic acids, chiefly) in the vacuoles, and on the other by those outside the cell. It will be seen, then, that the vacuole governs the process of absorption of raw food-materials; but it must be borne in mind that osmotic processes also govern in a cell-aggregate the distribution of circulating "food" (elaborated food) such as sugar, soluble proteids, and the amido-acids; all these substances are attracted to those living cells in need of them for purposes of construction, and here again the organic acids which possess a relatively high osmotic power are probably the determining factors in this attraction. The two processes, then, both absorption of raw food-materials and circulation of elaborated food, are dependent partly upon purely physical influences and partly upon the regulating action of the cytoplasmic membranes in the cell.

The "Bioplast" or "Pangen" Hypothesis, as a Biological Conception.

The hypothesis that the various structures met with in the cell are all ultimately derived from a common elementary body, the so-called "bioplast" or "pangen" is one which for some time now has occupied the attention of biologists. It argues that

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any part of the protoplast may be, according to the needs of the cell, transformed by chemical processes into any other, and the most striking instances in support of this hypothesis are, perhaps, to be seen in the origin of the plastids from the cytoplasm, and in the formation of zymogen granules from the living substance of the cell. Although this conception is open to considerable criticism, it is one which has to be taken into account; for it is well known that the protoplast, both animal and vegetable, is capable of a certain degree of adaptation to changed conditions of existence, and that structural variations in the cell are by no means uncommon under these changed conditions. The hypothesis, then, seems to be provisionally a sound one, but requires more discussion before it can be placed in the category of the more definite biological conceptions of the cell; more than this cannot be said at present, owing to lack of evidence.

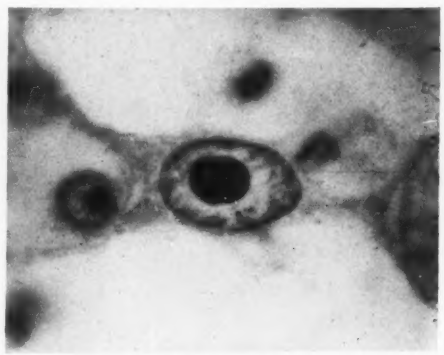

FIGURE 18.

A Photo-micrograph of the definitive nucleus in the embryo-sac of an Angiosperm (*Helleborus niger*) to show the nuclear membrane, chromatin, reticulum and one large nucleolus (to the left is the nucleus of the egg-cell).

CERTAIN PROBLEMS CONNECTED WITH CELL-METABOLISM: THE PROBABLE CAUSES OF PERVERTED METABOLISM: REACTION OF THE PROTOPLAST TO POISONOUS SUBSTANCES AND THE VARIOUS TYPES OF IRRITANT.

Some of the most interesting cell-problems are those relating to the unorganised ferments or *enzymes* manufactured by the cytoplasm, and the question of certain substances which are produced in the cell consequent upon irritation by the presence of bacteria or morbid influences in the immediate vicinity of the cell. The *enzymes* appear to be protein-like bodies which have a remarkable action upon (*a*) Carbohydrates, (*b*) Proteids, (*c*) Fats and (*d*) Glucosides, existing in the cell: the main factors in their action upon these bodies seem to consist in a process whereby *water* is first of all synthesised with them to form a somewhat unstable compound, and subsequently this compound is broken up again, with the result that several simple substances are formed, some of which are capable of being directly utilised during cell-metabolism for constructive purposes. The manner in which the enzymes are produced from the zymogen-granules is not as yet fully understood; it appears that the zymogen may be converted into the enzyme in certain cases by the action upon the former of a dilute acid or alkali, and that the production of zymogen in the cytoplasm is of a constructive (anabolic) nature, whereas the conversion of zymogen into ferment belongs to the destructive (katabolic) type of reaction.

Again, it is now well-established that in the case of the so-called organised ferments (*Saccharomyces*, *B. butyricus*, *B. lactis* and so on) the actual enzyme is a product manufactured in the actual yeast cells and bacilli, and then passed out of the cells into the surrounding medium; many of the toxins and toxic proteids (including also the so-called toxalbumoses are of this nature, otherwise known as *intracellular toxins*; but in certain cases, as, for instance, when bacteria gain entry into the tissues of the animal body, the actual cells of the tissue may react in a special manner and produce *anti-toxins* which tend to limit the production of toxins by the bacteria, or else neutralise such toxins.

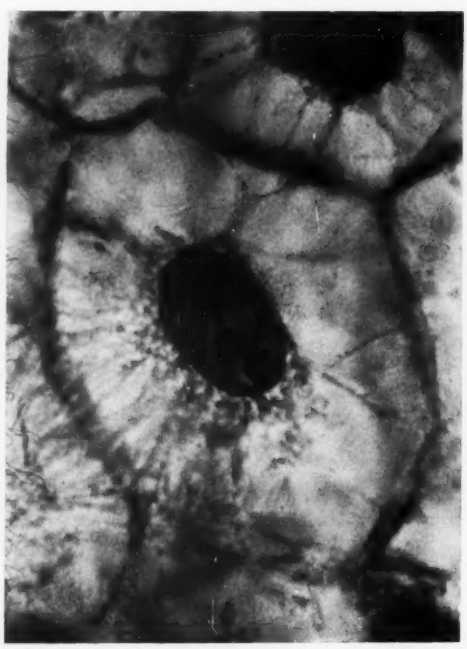

FIGURE 19.

A Photo-micrograph of a single cell of the Endosperm in the embryo-sac of an Angiosperm to show (on the left side) bridles of cytoplasm passing through the cell-wall to an adjacent protoplast. Note the oval nucleus with several nucleoli.

Of late years two other types of enzyme have been shown to exist in the cell in some cases; these are the oxidising and reducing enzymes (oxidases and reductases) and they have been found to be present in many plant cells. The oxidases are capable of furthering the oxidation of the cytoplasm in the absence of free oxygen, and it appears that the instances of so-called *anaerobic respiration* (certain bacteria) are due to the presence of some form of oxidase.

The question of proteid-metabolism in the cell is a problem which still remains largely unsolved; it seems, however, to be established that one of the intermediate stages consists in the combination of three classes of bodies, *viz.*, the *amido-acids*, some form of *carbohydrate*, and a *sulphur-compound*; but

the formation of the amido-acids themselves is a complex process. In the plant-cell in some cases, as was shewn by Pfeffer, it appears that calcium nitrate is decomposed by oxalic acid, nitric acid being set free and utilised in the formation of more complex nitrogenous compounds, and it seems that at times hydrocyanic acid may be used in the same manner.

Living protoplasm is constantly undergoing a series of oxidative and reconstructive reactions, and it is quite impossible to make a sharp line of distinction between the so-called anabolic and katabolic processes going on in the living substance; these two types of reaction are always going on hand in hand, and we must look upon the protoplasm as being the seat of a large number of oxidative and constructive processes, some of which are always going on; others, such as those concerned with the storage of food-substances (proteid, carbohydrate or fat), taking place only at certain periods, depending to a large extent upon the needs of the organism at the time.

It will be seen, then, that *normal* metabolism is a highly complicated series of interactions between various compounds in the cell; when the nutrition of a cell is modified in any way, either in quantity, quality, or both, the protoplasm is certain to react in some special manner to the changed conditions. Nutrition may be so profoundly modified that the cell may not be able to carry on any kind of metabolism, whether proteid, fat or carbohydrate, and in such a case function will be stopped or at least suspended. In many instances, when the medium surrounding a cell contains substances which act adversely upon metabolism (toxins, alkaloidal poisons, and so on), the protoplasm will not react in a manner adequate to cope with surrounding conditions, and subsequently the noxious substances gain the upper hand, the living substance passing into a condition known as "fatty degeneration"; this must be distinguished from true "fat metabolism" in the cell, since in the degenerative process no reconstruction takes place as in the normal cell.

Less virulent irritants acting upon the cell over long periods of time (chronic irritation) may, in the long run, produce marked changes in metabolism, and cells in which such perversion of normal metabolic processes has taken place may, if carried from one part of an organism to a remote part, set up similar perversions in the cells amongst which they settle. It seems, in fact, that once the cycle of metabolic changes in a cell has undergone a *complete* alteration, a cell is able to influence others in its immediate vicinity; it is possible that a substance or substances of the nature of toxins (cytotoxins) or enzymes may be produced which have a profound effect upon normal metabolism.

As evidence of the power which small quantities of certain substances have when distributed throughout a cell-aggregate, the various *internal secretions* manufactured in the animal body may be taken; there is no doubt nowadays that the thyroid gland, the suprarenal capsules, the islets of Langerhans in the pancreas, and the ovary manufacture internal secretions which are of immense value to the cells of the body in aiding the furtherance of normal metabolism, since, when any of these internal secretions is absent or produced in excess, it is found that metabolism is profoundly altered. The internal secretions formed in these bodies are in most cases protein substances, some of which are possibly akin to enzymes in their action; but their constitution is in many cases obscure, although their physiological action is definite enough in a few instances.

The above brief considerations will enable the reader to grasp the fact that the cell possesses a highly complex organisation, and that the processes going on in the protoplasm are of such a nature as to call upon our keenest powers of observation and experiment for the purpose of their elucidation: and it will have been gathered that not one of the least remarkable features in connection with cytological phenomena is the infinite capacity of the living cell to react to stimuli of varying nature, and to adapt its metabolism to altered external conditions.

GLOW WORMS AND LIGHTNING.

By ROBERT W. PETHEN.

THE common glow worm (*Lampyris noctiluca*) is a most interesting member of that large order of insects, the Coleoptera, and before proceeding to describe how I found this insect to be susceptible to the influence of lightning, I would like to make a few observations on its light-giving capabilities as shewn by the perfect female and also by the same insect when in the larval stage.

It may not be out of place to mention here that the glow worm gives forth a greater or lesser amount of light in every stage of its existence, including the egg, which "glows" more or less brightly when moistened with water and held in a dark place.

The beautiful phosphorescent light displayed by this little beetle is far more familiar than the insect itself, and although the female is popularly credited with being the cause of the twinkling lights to be seen amongst the grass and hedge-banks in certain

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favoured localities during the summer months, this is not always the case.

I have proved by actual experiment that the larvae have the power of emitting light from the moment that they leave the egg.

As the young larva increases in size, so the light-giving area of the anal segments becomes larger and also brighter, so that it is at times almost impossible to tell whether the light in the grass proceeds from a larva or a perfect female.

If the light of a full-grown female larva be closely compared with that of a perfect female, the former will be found to be smaller and also of a more greenish colour.

With regard to the duration of the light there is also a decided difference; for the light of the perfect female may continue to shine steadily for several hours when undisturbed, *i.e.*, from dusk until 1 a.m. or even an hour or so later; whereas in the larval form it is seldom that one finds the light shining continuously for more than a few minutes.

Glow worms, like ants, are very sensitive to vibration, and when approaching them in the grass one must not tread heavily, or they will extinguish their light and thus be lost to view.

This applies to the larvae as well as the perfect females.

If you pick up a female glow worm and turn it about in your hand, it feigns death and its light remains extinguished until all apparent signs of danger are past. Whilst it is still in the larval form, this insect behaves in quite a different manner under similar circumstances; for when turned about in the hand, it generally lights up at once, the light gradually dying away, but reappearing again and again as often as the insect is disturbed. It will light up in the same manner if the glass or box, or other vessel in which it has been placed, is smartly tapped with the fingers.

The glow worm larva will also give forth its light if it is sprinkled with cold water, or suddenly immersed in the same, while it is also apparently influenced by the effects of lightning, as I venture to think the following particulars will prove.

For several years I have been working at the life-history of the glow worm, and with this object in view I had, at the end of July, 1911, about a hundred and fifty larvae of *L. noctiluca*, all of them having been hatched between June 23rd and July 27th of that year.

These larvae were fairly evenly distributed in four glass tumblers. Each glass had a closely-fitting lid made of cardboard and fine wire gauze, and also contained a small moistened root of grass.

The four glasses containing these larvae were kept on the shelf of a hanging book-case in our sitting-room, in a rather dark corner about seven feet above the floor, and near a window facing east.

These tiny larvae would give forth a very small spark of light, if they were disturbed by tapping on the glasses, or even by tapping the shelf on which the glasses were kept.

On the evening of July 29th, 1911, we had a storm with thunder and much lightning, and as I happened to be at home, I thought I would see if the lightning had any effect on the larvae; having previously read a brief account* stating that glow worms were affected by it.

For an hour, from 8.15 p.m., when the lightning flashes were very frequent, I kept the larvae under observation. The unusual amount of electricity in the air certainly appeared to effect these larvae, for tiny bright greenish lights kept appearing and disappearing from first one glass and then another, right throughout the time that I was watching them. Occasionally there would be lights showing in all four glasses at one and the same time, when from six to twelve distinct points of light could be seen; at other times there would be only three or four lights visible.

No doubt many more of the larvae were affected in a similar manner; but their light would be hidden by the intervening roots and blades of the grass, amongst which they were generally to be found.

None of the flashes of light lasted more than a second or two, and they were all produced without any mechanical disturbance of the larvae.

The window was partly open, and although the hour was not very late, the corner of the room where the larvae were kept was dark enough for their lights to be clearly seen. The lightning had not ceased at 9.15 p.m.; but as we lighted the lamp at that time, the display of miniature fire-works could no longer be seen.

I watched and waited on many evenings afterwards, to see if the display would be repeated under normal weather conditions, but without result.

On the 19th of the following month (August, 1911), however, there was another storm in the evening with lightning, and the glow worm larvae acted in exactly the same manner as they did on the 29th July.

Unfortunately, I was prevented from making any further experiments in this direction, owing to my glow worm larvae all gradually dying off during last autumn and winter.

At the present time I have several hundred fresh larvae, hatched during July and August, 1912; but the warm thundery weather suitable for carrying out further experiments in this direction is still lacking; and here I will leave the matter for the present.

* See *Nature*, October 1st, 1903.

AN "IDEAL" MUSEUM AND ITS GUIDE.

By A PROVINCIAL CURATOR.

ON the principle that there are those who step in where angels fear to tread, I am venturing to refer to the very latest in the way of museums, namely the new London Museum, and its Guide.

Probably no museum ever came into being with such a flourish of trumpets as the new museum at Kensington Palace. The illustrated papers have given picture after picture of the museum's contents, or its curator, and have thus shown to an admiring world photographs of this, that, and the other object, scores of better examples of which are to be found in the many other London Museums, and even in provincial collections.

But I do not wish to deprecate the sweet uses of advertisement as adopted by the new museum. In fact, all admire its methods. And no doubt even our national collections would benefit if their recent additions were duly reported, described, and figured in the papers. But from illustrated interviews, special articles, pictures of people holding pots, and other items that have appeared in the daily and weekly press, it is clear that the museum is on extremely new and up-to-date lines. We are told that there are no headaches in the new museum! No confusing labels. Everything is simply and properly arranged, so that he who wishes may read the story of the city's growth and greatness from the time when the pool of London was wallowed in by men with oakum-covered arms and legs (such as shown in the museum "Annexe") to the time when a similar individual, bereft of his oakum, but in a boiled shirt, sits in a "Handsome" cab. And we learn that as the visitor flits from case to case a panoramic view of London's history is presented to him. And thus for the first time, so 'tis said, a visit to a museum is to be both pleasant and profitable. The curator and his assistants (we learn from the official "Guide"), are "luckily unhampered by the entangling meshes of red tape" and have consequently "achieved results which would have taken *ordinary officials*, less fortunately circumstanced, years to carry through." It is, perhaps, as well that there is no red tape, or the "author" would certainly not have been permitted to advertise his private literary ventures on the cover.

Being among the "ordinary" officials, and at all times anxious that the long-suffering ratepayers, who pay for my golf clubs and send me to conferences, should get the greatest possible benefit from the collections under my charge, I paid two visits to the new Museum, in order to derive inspiration from the work of its, presumably, "extraordinary" officials, and I paid a shilling for its "Guide"; but I only did that once! I was anxious to see this ideal museum, with its perfect classification, and its lack of red tape. I wanted to see (quoting from the guide book) "the palpable and material object lessons, more likely to impress the mind with the realities of the life of London in the olden times, than reams of dry sociological theories, learned historical disquisitions, and pompous moralising tracts." (To grasp the full import of the last sentence, it should be read three times!)

There is another paragraph in the guide which appeals to the provincial curator:—"Many private individuals, *moreover*, have generously come forward and presented their laboriously garnered stores ("laboriously garnered stores"!) illustrative of London's manufactures and arts, in order that these *cherished treasures* of theirs may become the heritage of their *fellow* Londoners—in being and *yet to be*! Others have munificently provided the funds requisite to enable the Trustees to acquire collections, *unequalled in their completeness*, of ancient costume, armour, weapons, pottery, glass, porcelain, enamels and silver! This "unequalled in their completeness" is pure piffle. The "author" (as he styles himself) of the Guide can never have been in the British Museum, The Victoria and Albert Museum, The Tower, The Wallace Collection, The Guildhall Museum, and many others not very far away: or if he has, he must have been "blind," in some way or other.

On my first visit it was raining, and I had an umbrella. This had to be left at the cloak-room, which was in another building some distance away, and the ticket I got in exchange was not large enough to keep the rain off while I walked back to the museum, and back again for the umbrella when I had seen it. I felt relieved that there were no "entangling meshes of departmental red tape" here, or I should probably have had to run round the park in my shirt.

On my second visit the weather was fair, so I was not requested to walk across the garden to leave my umbrella, but could carry it with me where I would!

As I entered the building I found two ways to the stairs; a wide one, open and free, and a narrow one, barred by a piece of wood—I believe polished oak—possibly to illustrate the kind of trees that once grew in London. I naturally went through the wide opening, and was going up the stairs when a policeman seemed to drop from an aeroplane or somewhere, hauled me back again, and made me push my frail form against the bar of oak, which proved to be a species of turnstile. I don't know what it registered me as, but doubtless, judging from the published numbers of visitors, a "large party."

I obtained my first object lesson before I had reached the top of the stairs. In order to inform visitors to "keep to the right," the best way is to hammer a nail into the middle of a large old oak panel, and hang a placard up on it. But upstairs, all my fondest hopes and anticipations fled. I found

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a number of rooms, of varying sizes, each crammed with as many mid-Victorian funereal exhibition cases as it could hold, and each case similarly crammed with as many specimens as possible. But each absolutely without any attempt at classification or arrangement. Even the rooms were not set apart for definite purposes, but similar objects were to be seen in almost every room, and in many instances, in several different cases.

By the press reports I was foolishly led to believe that I should first see specimens illustrating London in prehistoric times, then, step by step, through Roman, Saxon, Danish, and other periods, down to the present day. Nothing of the sort. Any object of almost any date could be seen in almost any room—nay—in almost any case! It is quite possible that the new London Museum is not unique in this respect; there may still be seen some musty collection formed by a "Literary and Philosophical" Society a century ago, in some old-world town, which is similarly "arranged." But in such instances the news is kept quiet. Anyway, it is not trumpeted forth, east and west, south and north, that perfection and classification *lies* here. And only of the new London Museum can it be said that the specimens are displayed (I am quoting now!) "Moreover, as much with a view to scientific precision as with a keen appreciation of the artistic effects of suitable surroundings and grouping; all, moreover (whenever "moreover" appears, I am quoting!) with the ever-present aim, not so much of instructing and educating the public, as of arresting their attention and stimulating their imagination—in a word—interesting and amusing them."

I am not quite sure whether the curator, or director, or keeper and secretary (who, by the way, did not write the Guide) has tried to act up to this ideal of *amusing* the public: but in some respects he has certainly succeeded.

To an ordinary mortal (if a provincial museum curator can be thus described) "classification" implies that objects of a similar kind, or similar period, are arranged together. Just as we should expect to find cabbages in a greengrocer's shop, trousers in a tailor's, and blouses at the draper's; so in the new model museum one might expect to find the pre-historic objects together, Roman objects together, mediaeval, and so on, all sorted and arranged, and china in one case, enamels in another, iron objects in another, coins in another, and so on. Such a method is the very alphabet of classification.

But, instead, case after case is filled with objects dating from pre-historic or Roman times to the nineteenth century, and case after case with iron objects, coins, pottery, embroidery, and so on, hopelessly and unaccountably jumbled. There is a good collection of bellarmines, all similar in shape and design, and of the same period, and all presumably found in London. Yet one must examine about fourteen different cases, and a mantelpiece or two, in various parts of the building, if he wishes to see all the bellarmines. Iron objects, such as knives and daggers, are well represented; but they are scattered in different sections of different cases, in different rooms. The china, enamels, embroideries, coins and medals might be considered to be representative, had one the patience or time to search for them all, and endeavour to carry them in one's mind. It can only be assumed that it is possibly the intention to illustrate the various historical periods in each individual case so that the visitor need not examine them all, but simply stand in front of any one case and then walk away with the history of London at his finger tips.

In addition to the Palace proper there is an "annexe," with prison cells, a Roman boat, a wooden Ancient Briton, Adam's fireplaces, and models of old London. This is arranged after the plan of the maze in Hampton Court, and there is quite an army of officials to push visitors the right way each time they go wrong. An extraordinary exhibition, and quite of a Madame Tussaud flavour, is that of a model of Jack Sheppard, the thief and robber, in his cell, apparently at dead of night, with a lantern dimly burning. And dare I interject, for the benefit of "the author," that even the name of this great hero is spelt incorrectly in the guide?

Still another building, a magnificent one that might be used so well, contains half-a-dozen palm trees and a "Handsome" cab. The number of people who stop and read the brass plate, and examine the cab, is astonishing, especially as probably many of them found their way to the museum by taking a seat in one.

I have already explained that I bought a guide. I thought perhaps it would act as a key to the collections. It cost a shilling. One shilling. I presume the price is arranged so that the Guildhall and South Kensington Collections may soon be purchased from the profits, and thus make the London Museum, *the* London Museum indeed. Anyway, I am not the first Northerner who has "Banged awa twa saxpences" in London!

The cover is a brilliant danger-signal red, and in the centre are the Royal arms, and "G.R." in large letters, which the policeman told me stood for King George, though he did not quite know how. On the inside cover we are informed of the hours of opening, the hours of closing, and that visitors are invited to communicate with the author if they have any suggestions to make! As I was not spending my holidays in the museum, I declined the modest request, but hope to forward a copy of this paper to him. There is no date on the cover of the guide. There is a portrait of Queen Mary as frontispiece, and the next page is dated 1912, so that one page at any rate is up-to-date. There is an introductory note (from which we have already quoted), then a view of Kensington Palace and Gardens in the reign of Queen Anne, and a portrait of the late Queen Victoria at the age of eight. This is dated May 24th, 1819. Then follows a "preface" which is dated May 24th, 1899, so that there seems to be the same glorious uncertainty with regard to the date of

the publication of the guide that there is with regard to the chronological arrangement of the specimens in the museum.

It is also apparent that the writer of the guide has some relatives who are oculists and opticians, who will certainly have to be consulted by anyone trying to read the pamphlet carefully.

On the title page we are told to "*Notice*"—"This catalogue and guide are copyright, and *immediate proceedings in Chancery* will be taken against any infringers thereof." As our old friend Pooh-Bah, F.L.A., would say, the punishment would certainly fit the crime.

The guide is a fair model of what a guide should not be. It is badly printed, with ancient type, on poor paper. The details of the cases are mixed up with the history of the Palace, and with a catalogue of the pictures, and there is no index; so that it is really a difficult matter to find anything in it. Many of the cases are not numbered at all, and we read of Case No. (long), Case No. (side), Case No. (centre), Case No. (side long), and so on. By the words side, centre, side long, and so on, I presume reference is made to the position of the various cases in their respective rooms, but as I was unsuccessful in identifying them, I cannot confirm this supposition.

An idea of the "scheme of classification" can be obtained from the following particulars of the first few cases, in which, if anywhere, an attempt at order has been made:—Case 1, Stone Ages, Bronze Age, late Celtic Period; Case 2, Ceramic Art. Case 3 (no heading at all! but apparently contains objects of the first to fifth century A.D.) Case 3, "continued"! Saxon Period; then follow "Relapse to Barbarism" (*sic*); Case 4, Early Mediaeval Pottery; Case 5, Battle Axes, Swords, etc.; Case 6, Wine Bottles; Case 7, Lighting Appliances; Case 8, Prehistoric Mammalia, etc. (the "etc." includes all sorts of things that ought to be miles away). Next is a "Green Coloured Bust' (*sic*), which sounds rather like a bilious attack! and a "Bell in case." Then Case 9, Mediaeval London, and so on to Case 12. A description follows of the "Queen's Closet" and "Pictures of Old London," followed by "Nos. 20 to 34," which are apparently pictures. After all this, oddly enough, is a heading in large type, "London Museum Exhibits," and it calmly proceeds to a list of the contents of Case 13. And the guide ends up with "A condemned Cell, Old Roman Galley, Mantelpieces, etc.; Panoramic Models of Old London, Lobby for various exhibits, Old Jacobean Room." It was with some such expression as "A condemned Cell" that I closed the "Guide," and thought of what might have been done with the shilling. However, I will not say it is useless; when folded round, and fitted with a pill-box lid on the top, it makes an excellent toy letter-box or money-box, coloured red, and with G.R. on it already complete!

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

OBITUARY.—The deaths of two well-known English astronomers have occurred recently. Sir George Darwin, the Plumian Professor, had been in failing health for some time, though he was able to read in person his last paper (on a new form of periodic orbit) to the Astronomical Society last summer. His principal work was on the theory of the tides, and their secular effects on the development of our system. He was the originator of the view (still, I think, held by most astronomers, though there are some important dissentients) that the moon was formed by tidal disruption of the earth by solar tides at a time when the rotation was very rapid, and that the moon has acted as a brake on the earth ever since, bringing the rotation to its present value, while the reaction on the moon has caused its recession. He was the author of a very useful popular treatise on the tides, which explains the method of Harmonic Analysis, and shows how the tides may be predicted for any port after a sufficiently long series of records is available. His work on periodic orbits was an investigation of the different paths a small planet might follow under the action of the Sun and an imaginary large planet, Jove, whose mass was one-tenth of the Sun's. This list of his works only includes those portions which are of most interest to non-specialists.

The death of Mr. S. A. Saunder, the Gresham lecturer, was far more unexpected. He was taken ill during his course of lectures on the Tides last October, but managed with difficulty to finish them. Many of our readers must have heard his lucid explanations of some rather difficult branches of astronomy. He was a Vice-President of the Royal Astronomical Society, and it was expected that he would before long fill the Presidential chair. The astronomical work for which he will be chiefly remembered was the accurate determination of the positions of a large number of points on the moon, using the beautiful large-scale photographs taken at Paris and in America. He found that the previously assumed positions were much in error; they had been made by measures at the telescope from the limb; he showed that it was far better to get them from measures on the photographs, provisional coördinates being first assumed for some leading points, which could be afterwards checked and corrected by the results. Accurate places of several thousands of points were thus found, and by comparing their positions in different librations it was possible to say which regions of the moon were above the general level and which below it. He showed that this was as difficult as finding the parallaxes of the nearer stars. He was superintending the preparation of a large map, on which the points measured by him were accurately laid down, and the filling in of detail done from the photographs. Mr. J. A. Hardcastle was associated with him in some of his work, and gave much help in the measures.

THE ALBEDOES AND BRIGHTNESS OF THE PLANETS.—Some photometric observations of the stellar magnitude and albedo of the planets have been made with the Draper Telescope at Harvard College Observatory. The result for Venus at mean superior conjunction was $-2^m\cdot56$ (thirty-four exposures on twenty-eight plates). The following magnitudes are for mean opposition:—Mars, $-0^m\cdot57$ (thirty-seven exposures on thirty-six plates); Jupiter, $-1^m\cdot78$ (twenty exposures, nineteen plates); Saturn, $+1^m\cdot52$ (twelve plates). The differences, photographic magnitude *minus* Müller's photometric magnitude, are:—Venus, $+1^m\cdot08$; Mars, $+1^m\cdot33$;

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Jupiter, $+0^m \cdot 57$; Saturn, $+1^m \cdot 23$. The Sun being of Spectral Class G, a difference of magnitude of $0^m \cdot 98$ would be expected, and this would be greater for the planets, as reflexion would tend to make the light redder. The deduced photographic albedoes are:—Venus, 0·66; Mars, 0·15; Jupiter, 0·80; Saturn, 0·53.

The very high value for Jupiter is noteworthy, and suggests that a little of his light may be inherent, especially as some portions of his disc are obviously dusky.

SATURN.—This planet has been in opposition in November, and now that it is getting into considerable North Declination it is attracting more attention from English observers, especially as Mars and Jupiter are invisible. It is most desirable that the disc should be searched for features sufficiently distinct to determine the rotation period. This differs very widely in different latitudes, from ten and a quarter hours at the equator to $10^h\ 38^m$ in the temperate zones; but it is most desirable that these values should be checked by other spots, and that it should be found whether the transition is sudden, or whether intermediate values exist. Spots sufficiently well marked to be easily identified on their return are not very common, and whenever one is seen it should be utilised to the full, and notice telegraphed to the possessors of large instruments.

Mr. P. Hepburn, the Director of the Saturn Section of the B.A.A., gave some interesting notes in November, on recent observations. A curious feature, confirmed by several observers, was a dark shading on the ring along the planet's limb, on the side opposite to the true shadow. This is a very perplexing observation, and I have not yet seen any plausible explanation. Mr. Hepburn also points out that careful observations should be made as to where the southern portion of the planet's limb lies on the ring, relatively to its southern edge and the Cassini Division. In this regard it should be remembered that the dimensions of the ring used in *The Nautical Almanac* do not include the latest measures, and that their value of the polar semi-diameter of the planet is faulty; what they give is the value of the actual polar radius as it would look if seen unforeshortened; but what we observe is a radius of the planet which is now twenty-four and a half degrees distant from the pole, and therefore decidedly longer.

LIMITING DISTANCE FOR HYPOTHETICAL SATELLITES OF NEPTUNE.—Mr. C. T. Whitmell recently gave me an interesting problem, *viz.*, to find the greatest distance at which a satellite of Neptune need be searched for. Dr. G. W. Hill in his researches on the Lunar theory, gave the elements of a satellite which had 1·7 lunations in the planet's year. The shape of the orbit is curious; its distance from the planet at Syzygies is only one-third of that at quadrature, and when the motion is referred to the line joining sun and planet (considered as fixed), there are cusps at the quadrature points. In the case of Neptune I find that such a satellite would be distant 0·30 astronomical units from Neptune in syzygies and 0·87 in quadrature. If the latter took place in opposition the satellite would appear 1·7 degrees distant from Neptune. As there is little chance of an actual satellite being so distant we may take one degree from the planet as the limit of useful search. A good deal of search has already been carried on by photography, but there is plenty of room for further efforts. In the case of very close satellites visual search would be more promising. All the probabilities point to Neptune having other satellites. but at such a distance only very large ones can be seen. Such tiny bodies as Phoebe, the outer satellites of Jupiter, or even (probably) the four satellites of Uranus would be beyond our reach.

PROFESSOR FOWLER'S DISCOVERY OF A NEW SERIES OF LINES IN THE SPECTRUM OF HYDROGEN.—Four sets of lines arranged so as to form regular rhythmical series were already known in the spectrum of hydrogen. A few stellar spectra showed evidence of a fifth series related to the fourth in a simple manner that suggested that it belonged to the same element. The lines were, however, much fainter than the others, and had not been detected in the spectrum of terrestrial hydrogen. This Professor Fowler has now succeeded in doing, taking the spectrum of the gas in a low-pressure tube, mixed with a little helium. He has not yet succeeded in getting the lines in the absence of the helium, but their exact accord with the formula for the fourth series, when one of the constants is halved, leaves practically no doubt that they belong to hydrogen. His paper was read at the December meeting of the Royal Astronomical Society.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

THE GENUS *LEITNERIA*.—In Engler's system of classification the genus *Leitneria*, constituting the order Leitneriaceae, is placed in a separate cohort (Leitneriales) near the base of the Lower Dicotyledons (Archichlamydeae) on account of its catkin-like inflorescence and simple flower structure. The two species of *Leitneria*, confined to North America, are shrubs with spikes of dioecious flowers; the male flower has from three to twelve stamens and no perianth, while the female has a scaly perianth and one carpel with a long style, the unilocular ovary containing a single ovule. Pfeiffer (*Bot. Gaz.*, LIII., 3) has made a thorough examination of the development of the flowers of this isolated genus, and finds that the ovule contains a single archesporial cell, differing from most of the Amentiferae or catkin-bearing trees in this respect, though the same condition occurs in *Betula alba*, *Alnus*, and some species of *Salix*—hence a multicellular archesporium can hardly be considered a group character. The young embryo is pear-shaped, and has a massive suspensor; there is no fixed sequence of cell-divisions in its development. The most striking features of *Leitneria*, however, are the resemblances which it shows to Gymnosperms; but such resemblances are also found commonly among the Amentiferae. The author's conclusion is that while the morphology of *Leitneria* is not such as would make it possible to place it definitely in any of the families of Archichlamydeae, it agrees with the Amentiferae in suggesting the possibility of the derivation of the lower Dicotyledons from Gymnospermic forms with compound inflorescences.

DEVELOPMENT OF *SALVINIA*.—Few groups of plants have been so much worked at as that containing the four "water-ferns" or Hydropterideae, though it is now generally recognised that the two families formerly classed together under this name ought to be separated somewhat widely, the Salviniaceae (*Salvinia* and *Azolla*) having probably arisen from a homosporous family like the filmy ferns (Hymenophyllaceae), while the Marsiliaceae (*Marsilia* and *Pilularia*) are probably connected with the Schizaeaceae. The most striking character of these two families is, of course, their heterospory—they are the only ferns with two kinds of spores—but they present many other interesting features. In a recent paper, Zawidski (*Beihefte zum Bot. Centralbl.*, Band 28, Abt. 1, 1912) gives an elaborate account of the development of the vegetative organs and sporangial receptacles (sori) of *Salvinia natans*, clearing up various points and giving a very complete picture of the morphology of this type. The growth of the shoot takes place with great regularity; the stem grows by a two-sided apical cell, and soon shows differentiation into nodes and internodes, each node showing four peripheral cells which form the initials for the two floating leaves, the submerged leaf, and the branch. All these organs grow by a two-sided apical cell, and this is also the case with the sori, each sorus being a metamorphosed segment of a submerged leaf. The oldest sorus produces the large spores (megaspores), the others produce the small spores (microspores).

MASSULAE OF *AZOLLA*.—In connection with the preceding note, mention may be made of a recent paper by Hannig (*Flora*, Band 102) on the development of the massulae of *Azolla*. This plant is, like *Salvinia*, a free-

floating aquatic fern, but it has roots, not modified root-like leaves, and its leaves are divided into two lobes, the upper lobe having a small cavity inhabited by the blue-green alga *Nostoc*. The spore-case groups (sori) are usually in pairs, the microsporangial sori being much larger than the megasporangial sori and the latter containing a single megasporangium with a single spore. The mega-sorus of *Azolla* has often been compared with the ovule of a seed-plant, the indusium being likened to the integument of the ovule. One of the most striking characters of *Azolla* is the presence of several masses of frothy substance (massulae) in each microsporangium, the massula having the microspores embedded in it while its surface is covered with curious barbed hairs (glochidia). The spongy massulae float about on the surface of the water; the mega-sorus sinks at first, but eventually decay of the indusium sets the spore free and it germinates, producing a female prothallus which rises and floats about on the water, becoming anchored to a floating massula by the barbed glochidia.

Hannig has investigated especially the structure of the massulae, and of the three curious floating-masses on the top of the megasporangium which are formed in the same way as the massulae. He finds that the substance (periplasmodium), from which the massula material is formed, is derived from the well-developed tapetum layer, the nuclei of which show repeated division. These periplasmodium nuclei lie originally just within the wall of the microsporangium, but later become scattered through the protoplasm; the periplasmodium increases in volume, stores up starch, and produces a number of vacuoles in which the microspores become enclosed. Within these vacuoles there appears a fine foam-like network, and from the surface of this foam there arise finger-like processes which become glochidia, developing recurved hooks at their tips. The periplasmodium is originally composed of living protoplasm, but eventually the walls of the foam-like structure become changed into cellulose, while the glochidia walls are cutinised. Hannig also examined the floating-apparatus of the megasporangium, and found that it is developed in exactly the same way as the massulae in the microsporangium; he detected the thirty-one abortive megaspores as irregular yellowish inclusions in the meshes of the floating-mass. He confirms the view of former investigators that the unisexual sori of *Azolla* have arisen from an originally monoecious condition.

MENDELISM AND PIGMENTATION.—The greater part of the President's address to the Botanical Section of the British Asssociation was devoted to a consideration of the methods of Mendelian research, with special reference to the chemical phenomena concerned in the production of colour in flowers. The Mendelian method is analogous to that of the chemist, who, given a complex mixture, sorts out the ingredients and submits them severally to analysis. The Mendelian analyst, given that complex mixture which is called a plant or animal individual, sorts out the ingredients and analyses them. The Mendelian analysis is made not by direct but by indirect methods; so long as the physical nature of living substance remains unknown we can hardly hope to resolve an individual into its physical components—all that can be done is to make comparative analyses of individuals, and discover how their several components differ from each other. For this purpose one may represent the individual by the equation, Individual=X + C, where C represents the sum of the Mendelian characters, and X the imaginary or real individual groundwork left after all the Mendelian characters have been removed by analysis. The Mendelian method is concerned directly with the resolution of C into its components. Indirectly, it is also concerned with X; for if the full value of C be determined, that of X may be inferred. This concession made, it is permissible to concentrate our attention on the term C, and the business of the Mendelian is to resolve this complex of characters into its constituent unit characters.

As the result of experimental analysis, Mendelism is enabled to state the problem of the behaviour in inheritance of two individuals in the following terms. The complex of characteristics which distinguishes an individual is the expression of the sum of a long series of characters. As the individual arises from germ-cells, so each character arises from a germ within the germ-cells—such germs of characters are called factors. When two germ-cells unite to form an incipient individual, or zygote, they bring together the similar factors of a given character—one factor from the one germ-cell and the other from the other. As the zygote forms the individual, so the paired factors give rise to a character of the individual. The body characters may be termed the flowers of the factorial seeds implanted in the germ-cells.

Some characters are simple and derive from one pair of factors only; others are of an ascending order of complexity and may be traced to the coöperative agency of two or more pairs of factors. In the case of a complex character the determining factors may be either like or unlike each other. Thus two pairs of different factors are required to produce the character of colour in certain flowers; but it is probable that certain characters are the outcome of repeated doses of the same factorial stimulant.

The individual is a dual thing, comparable to a double-barrelled gun, each barrel loaded with the factorial charge supplied by one of the two gametes or germ cells by whose union its duality is constituted. Conversely, a gamete or germ-cell is of single and not of dual nature; it has only one barrel and therefore can give effect to only one of the two factorial charges with which the individual was supplied at the time of its formation. The image of the double-barrelled gun serves to illustrate the several states in which an individual may exist with respect to its charge of factors of any given simple body character. Both barrels may be loaded—an individual in like state has two factorial charges and produces gametes all of which are alike in the possession of one of these factors; such an individual when self-fertilised, or mated with its like, produces gametes which are all alike in this respect, and these gametes, fusing in pairs, give rise to individuals which all possess the character in question; such individuals are homozygous, they breed true to the character. Neither barrel may be loaded—an individual in like state is also homozygous, it breeds true to the absence of the character. If a gamete of the former individual meet with one from the latter individual, the resulting zygote is like a double-barrelled gun with only one chamber loaded; the zygote is heterozygous for the character, and unlike the homozygotes, which breed true, the heterozygous individual does not breed true to the character in question.

From these propositions it may be predicted that the offspring of the heterozygote fall into three groups—one homozygous for the character, another heterozygous, and a third homozygous for the absence of the factor; and that these types of individual occur in the proportion of 1 : 2 : 1. This prediction is verified by experimental breeding from the heterozygote.

The Chinese Primrose, *Primula sinensis*, has given rise to many distinct varieties, white and coloured. It would appear self-evident that the white races differ from the coloured races merely in lack of pigment, but Mendelian analysis shows that there are more subtle differences between the different races. These differences become apparent when true-breeding white and coloured plants are crossed with one another; for it is then discovered that two types of white-coloured plants exist, and it is only by their fruits—their offspring—that we may know them. Thus, if certain white-coloured races are chosen for the experiment, the result of crossing white and colour is that all the offspring of the cross bear coloured flowers. If certain other white races are used and mated with the coloured form, however, the offspring all bear white flowers. In the former case, where the first generation (F_1) consists of coloured offspring, the second generation (F_2) raised by self-fertilising F individuals by crossing with one another, consists of coloured and white in the proportion of three to one; hence we conclude that the white used in this case owes its character of whiteness to lack of the pigment-producing factor which is present

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in the coloured parent race. This conclusion is confirmed by the genetical behaviour of the whites of the F_2 generation; such extracted whites breed true to flower-character, and give rise to white-flowered offspring only. White-flowered races which behave in this way are termed recessive whites. In the second case, where the F_1 generation consists of white-flowered offspring, the F_2 generation, from selfed or intercrossed F_1 plants, consists of three white to one coloured. The coloured offspring breeds true; of the three whites, one breeds true to whiteness and the other two give rise, like the white F_1 generation, to three white: one coloured. White races which thus impose their whiteness on the offspring of their union with a coloured race are known as dominant whites. Mendelians account for the genetical behaviour of dominant whites by assuming that they carry the character for colour, and also a character for colour-inhibition. This hypothesis, though novel to Biology, is amply justified by genetical results, and it propounds a series of questions to the physiologist and biochemist.

Until recently, knowledge of the processes of pigmentation has advanced along two main and independent lines:—(1) that followed by students of genetics, which has led to a wealth of exact knowledge concerning the factors and characters which determine coloration; (2) that pursued by biochemists, which has resulted in a great increase of our understanding of the biochemistry of pigmentation. The first to combine the genetical with the biochemical method was Miss Wheldale, to whom we owe a good working theory of the nature of the processes involved in pigment-formation.

Palladin has shown that respiration consists of a sequence of enzyme-like actions, the later of which result in oxidation and are ascribed to the enzymes (ferments) called oxydases; that chromogens play a part in the oxidations set up by oxydases, and that these colourless chromogens may undergo either alternate oxidation and reduction and so take a continuous part in oxydase action, or undergo permanent oxidation and so constitute the pigments of the plant. Chodat and Bach have suggested that oxydases are of dual nature, the complete oxydase consisting of two parts—a peroxydase and an organic peroxide. An oxydase reacts with oxidisable reägents, such as guiacum, to produce a characteristically coloured product; hence these reägents may be termed oxydase-reägents. Peroxydases react with oxydase reägents only if there be added, as a substitute for the organic peroxide of the complete oxydase, a source of active oxygen in the form of hydrogen peroxide. Both oxydases and peroxydases occur in the cells of plants, and may be identified in extracts therefrom. Gortner's work on the pigments of insects confirms the view that pigments are the product of the action of oxydase on chromogens; he has shown that the black or brown melanin of the integuments of insects is produced by the action of an oxydase called tyrosinase upon some such product of protein-hydrolysis as tyrosin.

Miss Wheldale's theory is that the anthocyan pigments of plants are the outcome of a series of chemical changes of the following order:—Glucosides on being hydrolysed by the ferment emulsin yield chromogens which, acted upon by oxydases, give rise to anthocyan pigments. The difficulty in the way of further advance lay in the unsatisfactory nature of the methods for identifying oxydases derived from plant tissues. When Professor Keeble and Dr. E. F. Armstrong began their work on this subject they found, after trials of various known reägents, that α naphthol and benzidine are each suited admirably for the purpose of locating oxydases, and by means of these reägents they have been able to map out the distribution of oxydase and peroxydase in the flowers and other parts of various plants. Their results confirm Miss Wheldale's hypothesis of the mode of formation of anthocyan pigments; but this confirmation was made possible only by reason of the fact that they worked with races of plants bred on Mendelian lines and therefore of known genetic constitutions.

On treating coloured flowers of *Primula sinensis* with each of the two reägents, it is found that the actions of α naphthol and benzidine are in considerable measure supplementary one of the other. Thus, the lilac-blue α naphthol reaction is confined to the veins of the corolla; the brown benzidine reaction is shown by the superficial (epidermal) cells and also by the veins. The peroxydases are therefore termed epidermal peroxydase and bundle oxydase, the former occurring in the epidermis and hairs, the latter in the bundle-sheath which accompanies the veins. Similarly, the stem of *P. sinensis* contains a superficial peroxydase and a deep-seated peroxydase. The distribution of peroxydase coincides broadly with the distribution of pigment; that is, the peroxydase framework for pigmentation occurs throughout the species, and the building of the several colour varieties is determined by the activity of the factor for chromogen production, and if we conceive of this factor as administered in a series of doses we have a picture of the mode of evolution of the series of varieties characterised by increasing or decreasing amount of pigmentation of their parts.

The application of these reägents to *recessive* white races shows that these white-flowered races, though lacking the factor for colour, contain in the flower both epidermal and bundle peroxydase, as might be expected from analogy with the peroxydases of the stem. Hence we conclude that the absence of colour from recessive white flowers is due not to the absence of peroxydase, but to absence of chromogen, and this conclusion conforms with that arrived at previously by Mendelian methods, which show that anthocyan pigmentation of the flower of *P. sinensis* depends on the presence of one factor only, and that the absence of pigmentation characteristic of recessive whites is due to the absence of that single colour-factor.

The investigation of the peroxydases of *dominant* white flowers gives a very different result; for these show no sign of peroxydase either in epidermis or in bundles. Hence such flowers either lack peroxydase or else they contain a substance which inhibits peroxydase from exercising its oxidising action on the oxydase reägents. It is known that the addition of certain phenolic compounds (orcin, resorcin, and so on) prevents tyrosinase from exercising its characteristic action upon tyrosin. Assuming that an inhibitor of peroxydase exists in dominant white flowers, it may act either by destroying the peroxydase or by setting up conditions under which the activity of peroxydase is arrested; and if the latter is the mode of action, it follows that if by some means the inhibitor can be removed, the peroxydase will be free to effect the oxidation of the reägents used. This train of reasoning led Keeble and Armstrong to the discovery that hydrogen cyanide forms a means of removing peroxydase inhibition; if dominant white flowers are immersed in a dilute solution of hydrogen cyanide and then treated with either of the two oxydase reägents together with hydrogen peroxide, pronounced peroxydase reactions are obtained both in the epidermal and bundle tissues of the corolla.

To test this hypothesis further, a race of Primulas was used in which the flowers are blue with white patches on each petal, the known ancestry of this race indicating the probability that the white patches are produced by a localised inhibitor. On treating corollas of these flowers with the two oxydase reägents and then with hydrogen peroxide, the parts originally blue are stained lilac-blue or brown according to the reägent used, and the inhibitory patches stand out as in the intact flower as white areas on the coloured ground. If, however, these parti-coloured flowers are treated first with hydrogen cyanide, then with the reägent and subsequently with hydrogen peroxide, the peroxydase reaction is produced over blue and white areas alike—the inhibition located in the white areas has been removed. Hence the Mendelian hypothesis of the inhibitory nature of dominant whites is confirmed by biochemical methods; these methods, moreover, prove that the inhibitor acts not by destroying but by preventing the action of oxydase upon the chromogen.

This fruitful line of investigation has given various other results and has raised many questions for further research. For instance, the close proximity in the flower of the superficial and deep-seated oxydases suggests that the latter may coöperate with the former in producing flower-pigments. This possibility entails the hypothesis of a translocation of oxydase from the region in which it is secreted to that in

which it acts; and there are various facts in favour of this view—the lines of deep colour that occur along the veins of many flowers, the frequency with which the walls of cells appear to contain oxydase, the occurrence of oxydase in the mesophyll cells adjoining the bundle sheath, and the evidence provided by the mutual influence of stock and scion in grafted plants and in graft-hybrids.

Again, it has been found that the nature and amount of oxydase contained in a plant tissue varies in an orderly manner according to external conditions. Among the conditions which determine this fluctuation are light and darkness. Plants subjected to normal illumination possess less oxydase than those kept in darkness; after one or two days of exposure to darkness, plants of *P. sinensis* contain more peroxydase than sister plants kept under normal conditions of illumination.

Should the results of similar investigations with other plants show that this diurnal variation of the oxydase content of plant tissues is general, we may perhaps discover therein the means whereby many of the phenomena of periodicity shown by plants are maintained and regulated. The light and darkness of day and night set up rhythms in the plant; the leaves of various plants assume nocturnal and diurnal positions, and the rhythm thus established may be maintained for a certain time under uniform conditions of illumination, as in the Sensitive Plant and many others. Animals also show a similar periodicity; the shrimp-like *Hippolyte varians* rolls up its brilliant pigment-bodies (chromatophores) at night and becomes sky-blue in colour; but when daylight comes the pigment of the chromatophores is spread out in superficial networks. Kept in darkness these animals retain for many days this periodic habit, and when the hour of night arrives, though they have no light to tell it by, they lay aside their daily garb and put on the uniform of night. So also the "plant-animal" *Convoluta roscoffensis*, which lives on the seashore, orders its behaviour by the sun and moon, lying on the sand till the waves of the rising tide are upon it and then descending to security and darkness; when the tide recedes it rises to the light. Even the uncongenial surroundings of a tea-cup and a laboratory fail to break this habit; for in these surroundings its uprisings and down-lyings keep time with the tides. It is possible that light and darkness may work these wonders of periodicity and rhythm through the control of chemical agents such as oxydases.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

THE HARDENING OF FATS.—For many years one of the chief problems of the oil industry has been to obtain a harder material from soft fats, and numerous ingenious methods have been tried, though only with limited success. The chemical problem involved in the ideal process is the addition of hydrogen to unsaturated fatty acids or their glycerides as represented, for example, in the case of oleic acid by the equation:—

$$C_{18}H_{34}O_2 + H_2 = C_{18}H_{36}O_2$$

oleic acid — stearic acid

Oleic acid is the chief constituent in most oils, while stearic acid is a main constituent of solid fats such as lard and tallow.

All attempts to make the hydrogen combine with the unsaturated compounds in this way proved failures until a few years ago it was discovered by MM. Sabatier and Senderens that the combination could be effected by bringing the hydrogen and the liquid fat together at a high temperature in the presence of finely-divided nickel, which acted as a catalytic agent.

This discovery was followed by other processes in which other metals or metallic oxides such as cobalt, palladium and platinum were used as the catalytic substances, and numerous patents on these lines have been taken out for the manufacture of solid fats suitable for food and candle-making from liquid and semi-solid fats.

In the current issue of the *Chem. Rev. Fett Ind.*, (1912, XIX, 247) there is a description by Dr. A. Bömer, of the chemical and physical properties of a number of these hardened fats prepared from earthnut oil, whale oil and cotton seed oil. In each case solid products resembling lard or tallow, according to the duration of the process, were obtained. From whale oil, for example, a hard white tallow-like fat melting at 45·1° C. was prepared, while earthnut oil gave a product which closely resembled lard both in its appearance, chemical properties, taste and smell.

As these hardened fats are now being sold as food products physiological tests were made to discover whether any injurious substances were formed in the process, but they were found to be quite innocuous, provided that care had been taken to eliminate all traces of the nickel used in the manufacturing process. Stress is laid upon the point, however, that only liquid fats that are already fit for human food should be used as the raw material, while such fats as horse-fat, bone fat, whale oil and the like should be kept for technical purposes such as the making of soaps and candles.

METROPOLITAN WATER BOARD'S REPORT.—The sixth annual report of the results of the chemical and bacteriological examination of the London waters, which has just been published, contains many details of great interest, to which here it is only possible to allude briefly. The *raw* waters, from which the supply is drawn, consist principally of rivers that have previously been polluted with sewage, and in the future it will be an increasingly difficult matter to obtain sufficiently satisfactory water to meet the greater demands upon the waterworks. Obviously, the greater the quantity of the water drawn from a river the more impure will be that which remains. Chemical purification of sewage effluents has rendered them much less objectionable; but apart from sterilisation there is no practical method of removing bacteria from these effluents.

Fortunately, the effect of mere storage of the water is automatically to reduce the number of bacteria to the extent of over ninety-nine per cent., so that on subsequent filtration of the water a reasonably safe filtrate is obtained. For example, the average number of microbes in raw Thames water during the twelve months ending March, 1912, was 9155 per cubic centimetre, while after subsidence and filtration of the water there were only 17·2 per cubic centimetre. In Dr. Houston's opinion it is hardly conceivable that any pathogenic micro-organism would succeed in reaching the filter beds after a sufficient period of storage. At the same time he lays stress upon the importance of obtaining water in as pure a condition as is practically possible, notwithstanding the proved safeguard afforded by efficient storage. Theoretically it should be possible to bring all river water to the same degree of purity before its intake into the waterworks and its delivery to the filter beds; but in practice during periods of flood it is necessary either to draw upon such water, which is unsuitable for the purpose, or to deplete the reservoirs by closing the intakes and thus reduce the period of storage for water subsequently taken into store.

For these reasons Dr. Houston advocates the desirability of taking greater supplies of water at favourable periods than is at present permitted. Apart from this, it is suggested that supplementary processes of purification might with advantage be employed occasionally, in addition to the present processes of devitalisation of bacteria by sedimentation and removal of the bulk of the remainder by filtration.

CHEMISTRY AT THE BRITISH ASSOCIATION.—The address of Professor Senier, President of the Chemical Section at the Meeting of the British Association in Dundee, is an interesting outline, full of suggestion, of what chemistry is and by what methods it works. It is clearly demonstrated that imagination is necessary for the advance of the science, and that our educational resources should be devoted to assisting promising students in the direction of research rather than to giving an elementary smattering of indigestible facts to everyone.

Of the papers of more general, apart from purely chemical interest, mention may be made of *The Report of the Committee on the Study of Plant Enzymes particularly with*

XUM

Relation to Oxidation; and the very important *Report on Diffusion in Solids* by Dr. C. H. Desch, in which the conclusion is drawn that "the occurrence of diffusion in metals is established beyond any doubt; but that experiments are still lacking to prove its occurrence in transparent crystals of minerals, salts, or organic substances, even under favourable conditions, although, even here, indirect evidence points to its possibility."

Other notable papers are *On the Dissociation of Phosphorus Vapour*, by Professor Stock and Dr. Gibson, and *The Chemical Nature of Uranium X, Radio-Actinium and Thorium B* by Mr. Fleck, who was unable by means of fractional precipitation to effect any concentration of the short-lived radio-element in thorium, or to separate thorium from radio-actinium or thorium B from lead.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

GEOLOGY OF THE LIZARD AND MENEAGE.—A memoir with the above title has just been published by the Geological Survey, and written by Dr. J. S. Flett and Mr. J. B. Hill. The Lizard has long been a happy hunting ground for geologists, largely on account of its fascinating petrological problems, especially those connected with the great mass of serpentine which is the central feature of its geology.

The Lizard area can be divided into a northern and a southern portion. The dominant feature of the northern portion is the occurrence of four bands of sedimentary rocks (killas or clay slate, with subordinate grits, limestones, and conglomerates), named the Mylor, Falmouth, Portscatho, and Veryan series respectively, of which the last-named is the youngest, and has been determined by fossil evidence to be approximately of Llandeilo or Arenig age. Volcanic activity in Veryan times gave rise to the well-known spilitic lavas of Mullion Island, which are interbedded with limestones and radiolarian cherts.

The southern area is composed of a great metamorphic series, consisting of sedimentary and igneous rocks, of which the latter are overwhelmingly predominant. The metamorphosed sedimentary rocks are the oldest, and consist of mica-schists, granulites, and green schists, containing also hornblende schists of undoubted igneous origin. Subsequent to the formation of these rocks, an intrusion of granite took place. This rock has been greatly metamorphosed, and is now a highly foliated hornblende gneiss, which occupies the Man of War Islands off the Lizard shore.

Before the intrusion of the great serpentine another sedimentary formation was deposited, the Treleague quartzite, a quartzose rock in which the original pebbly structure is well preserved. In many places also, on the margin of the serpentine, there are coarse, gnarled, hornblende schists—the Traboe schists—representing the coarse dolerites or gabbros which immediately preceded the great plutonic intrusions.

The serpentine covers an area of twenty-one square miles, and is probably the largest serpentine mass in the British Islands. It has a more or less circular outline and is clearly a large laccolite or boss similar to the granite bosses that stud Cornwall and Devon. Three main varieties have been distinguished, the cherzolite or bastite-serpentine, the tremolite-serpentine, and the dunite serpentine. The first named of these is the rock which affords the beautiful ornamental stone for which the Lizard serpentine area is famous.

Later the serpentine was invaded by some bosses and an enormous number of dykes of gabbro. In many localities these have been crushed and rolled out with the formation of "flaser"-gabbros. After the cooling of the gabbro, a further injection of basic material took place, giving rise to abundant black dykes of olivine-dolerite, many of which have been crushed into epidiorites and hornblende-schists. Before this episode had finished, a final uprush, this time of acid material, occurred; and in some places, a mixed or hybrid rock, consisting of imperfectly mingled acid and basic material was produced, forming a heterogeneous banded gneiss called the Kennack Gneiss.

It is interesting to remark how this long and intricate igneous period of the Lizard is paralleled in the Ordovician of Ayrshire. Here also is a large mass of serpentine, intruded by gabbro and dolerite dykes with later masses of acid material. These intrude Ordovician sediments, the basal portions of which contain numerous flows of spilitic lavas associated with limestone and radiolarian cherts just as in the Mullion Island district of Cornwall.

THE PETROLOGY OF SANDSTONES.—The petrological study of the sedimentary rocks is now an important adjunct to their stratigraphical study. The investigation of the constituent grains of a sandstone is often especially helpful in obtaining an idea of the mode of origin and the derivation of the rock. Important results are being obtained from the study of the Scottish Carboniferous sandstones. An investigation by Mr. T. O. Bosworth, brought forward at the British Association, shows that these sandstones belong to two entirely different kinds, those in which the heavier mineral grains consist mainly or largely of garnet, and those in which garnet is absent or scarce. As far as Mr. Bosworth has yet examined the Carboniferous succession, the Coal Measure sandstones have been found to be highly garnetiferous, whilst those of the underlying Millstone grit were almost entirely non-garnetiferous. In the sandstones of the Carboniferous Limestone Series, out of fifteen samples examined, nine were garnetiferous, and six devoid of garnet. The Calciferous Sandstones were found to be entirely non-garnetiferous.

The garnets, and indeed all the heavy grains, were found by Mr. Bosworth to be characteristically angular. The garnets were broken along the dodecahedral cleavages, giving elaborate zig-zag shapes with numerous corners and edges. These grains were in marked contrast to those found in desert sands.

An independent investigation by Mr. W. R. Smellie (*Transactions of the Glasgow Geological Society*, 1912) of the Upper Red Barren Measure sandstones, which overlie the Coal Measures to the east of Glasgow, shows that the sandstones suffer a progressive change upwards in regard to mineral content and the degree of rounding. The lower beds are still characterised by angular garnets, but these do not occur to nearly the same extent as in the Coal Measure sandstones. The higher beds, however, are devoid of garnet, and contain abundant zircon, rutile, and tourmaline, the grains of which are frequently well-rounded and polished, especially the zircons.

MICROSCOPY.

By F.R.M.S.

LOW POWER PHOTO-MICROGRAPHY.—BACKGROUNDS.—It is a practical maxim in picture making of all kinds, scientific, technical, and pictorial, that nothing is seen without a background.

Thus a uniformly lighted quite white object is unnoticeable against a uniformly lighted equally white background.

The next point is that the useful effect of a background is to show contrast. This is so obvious that that it is very frequently entirely ignored. In Figure 20 we have a precisely similar pair of tiny cowrie shells side by side, similarly lighted. That on the right is backed by black paper, that on the left by a bit of white postcard; the two backgrounds being pasted side by side on an ordinary micro slip so that both parts had the same lighting, exposure and development.

First we notice that the shell on the right seems to be decidedly lighter than that on the left. But this is an optical delusion due to contrast effects with the backgrounds. Next we notice that with the light background (left) we get a decided cast shadow as well as a shaded side, and that where this side of the shell is close to the light card background we get a little reflected light on the shadow side, while with the

black background (right) the cast shadow is apparently absent though really present.

It may be here noted that general experience among photographers shows that with a dark background we require a little longer exposure than with a light background, all other things remaining the same. With certain types of subjects it is desirable to employ a light background in conjunction with a side lighting, but without any cast shadow such as shown in my last note.

This can be easily accomplished in those cases where the object can be affixed to an ordinary clean, clear glass micro-slip. This is now held by the spring clips in front of the cut out part of the holder, and then a suitable white ground (*e.g.*, postcard) put in a position and angle where it is well and evenly lighted, and a few inches away from the object.

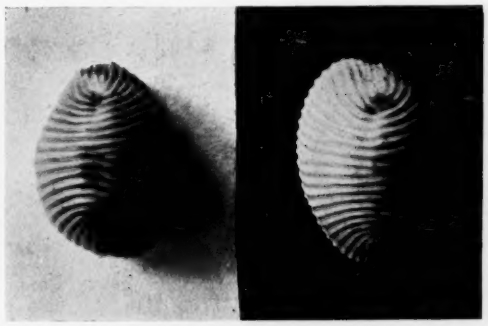


FIGURE 20.

In Figure 22 we see this arrangement showing a postcard background and glass-supported tiny shell and in Figure 21 we have the result showing the object enlarged about four diameters with a side lighting, light ground and no cast shadows.

In Figure 23 we have a (practically) white shell supported on a glass slip in a side lighting, against a black ground. In this case the ground was a bit of black velvet pasted to a piece of cardboard. It is far enough away to be quite out of focus and shows no texture.

Next comes the question of a reflector, which in some cases is of special value. In Figure 24 we see an object stuck to a glass slip, and a bit of white card close behind it. To our right we see a postcard used as a diffusing and reflecting screen throwing light on to the shadow side of the object. (The postcard is affixed to the base board with a couple of drawing pins.)

FIGURE 21.

In Figures 25 and 26 we see the effect of the non-use and use of such a card reflector in the case of a light shell showing some curious black markings. In the one case we get a dark shaded side and a cast shadow on the background. In the other case we nearly get rid of the cast shadow and also see a great deal more detail on the shadow side of the object as well as seeing more of the inside of the shell mouth.

These two examples, Figures 25 and 26, are precisely similar as regards lighting, exposure, and so on, and in all other respects, except the matter of the reflector.

One word of warning: do not use a glass mirror, or even a glossy card, or cross lighting and other ugly effects are likely to arise.

For all work of this kind it is preferable to employ bright sky light rather than direct sunlight. If direct sunlight falls on the window this should be covered with a piece of thin fine white muslin.

F. C. LAMBERT, M.A., F.R.P.S.

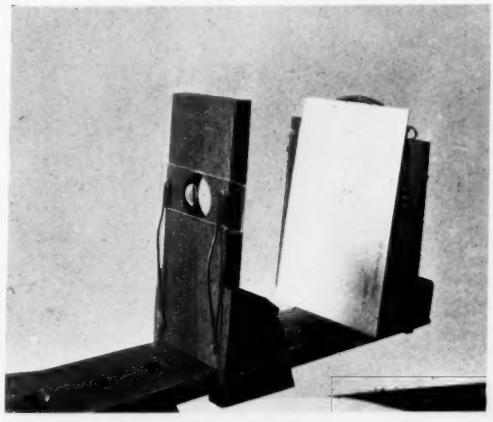


FIGURE 22.

QUEKETT MICROSCOPICAL CLUB.—November 26th, 1912.—The President, Professor A. Dendy, D.Sc., F.R.S., in the chair.

The President made some remarks on new species of Holothurians, with special reference to a form of *Chiridota* found in Port Phillip Bay, Victoria, and described by E. C. Joshua as *Taeniogyrus allani*. It was not, as was at first thought, identical with *Chiridota dunedinensis* Parker.

Mr. E. M. Nelson, F.R.M.S., read a paper "On microscope construction and the side-screw fine-adjustment." He pointed out that the modern method of placing the coarse-adjustment slide and the body upon the fine-adjustment, and the side-pinion fine-adjustment (now so much in vogue), were both invented by Powell, in 1841. The disadvantages of modern horizontal fine-adjustments were mentioned, and an improvement suggested by the author, preventing injury to the delicate moving parts, was described. The same author also made some remarks on "a new low-power condenser," and referred to the impossibility of obtaining an evenly lighted field, under critical illumination with any power lower than a two-thirds. Substage condensers suitable for low powers are all of too short a focus. A sufficiently long-focus condenser cannot be used because there is not room to focus it, even on a Powell and Leland No. 1 stand. The author had surmounted the difficulty by designing a condenser on the telephoto principle. This was exhibited at the meeting by Mr. Baker. It had an equivalent focal length of four inches, but required only one inch of working distance.

ROYAL MICROSCOPICAL SOCIETY.—November 20th, 1912. H. G. Plimmer, Esq., F.R.S., President, in the chair. Messrs. E. Heron-Allen and A. Earland read a paper on the Distribution of *Saccammina sphaerica* M. Sars and *Psammosphoera fusca* Schulze in the North Sea; particularly with reference to the suggested identity of the two species. These Foraminifera, belonging to the family Astrorhizidae, and originally described as from the North Sea, but occurring also in all the great oceans, have been the subject of considerable controversy. Dr. Ludwig Rhümbler asserts that *Psammosphoera* is only an immature stage of *Saccammina*. As a result of the examination of about one hundred and fifty dredgings made in the North Sea, the authors have no hesitation in affirming that the life-history of *Saccammina*, as recorded by Rhümbler, is a composite sketch involving three separate and generally recognised specific organisms:—

Stages I–III represent the life history of *Crithionina mamilla* A. Goes.

Stage IV is *Psammosphoera fusca* Schulze, an extremely variable species, which occurs both free and sessile, but is in all its stages normally recognisable by the absence of a general aperture.

Stages V–VII represent the complete life-cycle of *Saccammina sphaerica* Sars, so far as it is a shell-bearing organism.

An abstract of a paper by the Rev. Hilderic Friend on British Henleas was read. The Henleas are microscopic annelids belonging to the family of Euchytraeids. The genus

was created in 1889 by Michaelsen, and contained four authentic species and four which were doubtful. Another species was added in 1899 by Bretscher. In 1900, when "Das Tierreich" was published, the number recorded was five, with four doubtful forms. During the next decade some progress was made, eight new species being added, and four definitely recorded as British. In 1911 Friend described *H. perpusilla*, and added one or two others to the British list. The present paper gives an enumeration of no fewer than nineteen species, eighteen of which are found in England and one in Ireland. Of these, seven new to science were found at Hastings in December last, and three have been found in Nottingham during the present year. Descriptions, with figures, are given of *H. marina*, *H. curiosa*, *H. arenicola*, *H. heterotropa*, *H. attenuata*, *H. fridericoides*, *H. variata*, *H. triloba* and *H. fragilis*, all new to science. The paper closes with a carefully prepared table, by means of which the various species can most readily be distinguished.

FIGURE 23.

An abstract of a paper by Mr. James Murray, F.R.S.E., on African Tardigrada was read. This paper adds thirteen species to the list of African Tardigrada, twelve were described in the author's previous paper, and Daday added a new species, *M. tetronyx*. There are now twenty-six species recorded for Africa, eighteen for tropical Africa, and seventeen for South Africa. Nine of these were first discovered in Africa, and only one of them (*E. perarmatus*) has been found outside that continent. Our knowledge is still too incomplete to allow of any useful study of the origin and distribution of the African Tardipode fauna. Amended and fuller descriptions are given of *E. africanus* and *M. crassidius*. Only one new species is described, *M. allani*, but there are figured varieties of *E. crassispinosus*, *E. duboisi*, and *hupelandioides* which are probably of specific value, to which I give no names. In the present state of the group it is well to be cautious in making new species, till our knowledge is consolidated in some monographic work.

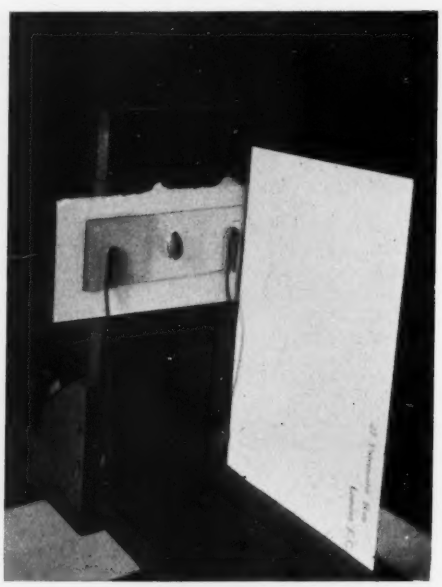


FIGURE 24.

INSECT INTELLIGENCE. — At a meeting of the Royal Microscopical Society on December 18th Mr. Frederick Enock, under this title, described how a wood-boring wasp brought no less than twenty-seven examples of the rarest British "Daddy-long legs" (*imperialis*—of which Mr. Enock had only taken one in forty years) and in order to get them into its burrow, cut off the six legs and the two wings close to the body.

FIGURE 25.

FIGURE 26.

ORNITHOLOGY.

By WILFRED MARK WEBB, F.L.S.

THE CUCKOO.—As an instance of the interesting information which one can sometimes glean from a catalogue one may mention that of Major Proctor's collection of birds' eggs recently sold by Mr. Stevens. That the cuckoo chooses a nest of the same species of bird in which to deposit its eggs is shown by two eggs evidently laid by the same individual, one taken from a Reed Warbler's nest on May 31st, 1907, and the other from that of the same species in the same place (Twyford, Berks) six days later. That the Cuckoo deposits two eggs in the same nest was shown by that of a Hedge Sparrow found at Dean, in Hampshire, on May 31st, 1893. Another Cuckoo's egg in the collection was found by Major Proctor in a Blackbird's nest at Torquay in 1889.

THE RECOVERY OF MARKED BIRDS.—In *British Birds* for December a report on marked birds that have been recovered, is given. In many cases the specimens were recaptured in the same place. One or two of the instances of birds that have travelled a considerable distance we may give. A Linnet marked by Mr. Masefield at Cheadle, Staffordshire, as a nestling, was caught at Wellington, Salop, on September 25th in the same year. A Pied Wagtail, marked by Mr. Ford-Lindsay at Pett, Sussex, on June 20th, 1912, was recovered at Blaye, Gironde, France, on October 6th. A Whinchat and some Cormorants, Common Terns and Little Terns also went to France. A Lapwing, marked by Lord Lucas in Yorkshire on June 19th, 1912, was recovered in Portugal in November of the same year.

THE DARTFORD WARBLER IN IRELAND.—Mr. R. M. Barrington, in *The Irish Naturalist* for December, records the occurrence of the Dartford Warbler in Ireland, a female having been caught at the Tuskar Lighthouse, County Wexford, by Mr. A. O'Leary, the light-keeper, on October 27th. The Dartford Warbler is looked upon as a resident in England, and was said in 1880 not to be uncommon on furzy ground in the Land's End district. Mr. Barrington thinks that if a pair had arrived in County Wexford, where furze is more prevalent than any Irish, or probably English, county, a colony might have been established; that is to say, were the birds lucky enough to escape being killed by a collector or some other misguided person.

NESTING-BOXES IN RUSSIA.—In many parts of Russia, especially in the towns along the Baltic, the traveller cannot help being struck by the numbers of nesting-boxes in the gardens and courtyards. This is particularly noticeable in the quaint old town of Libau, where in almost every garden, however small, a nesting-box may be seen. These boxes are invariably stuck on the top of a pole—never against the trunk of a tree or the side of a house as with us in England. In many cases a small branch is fixed to the box to render the site more natural and attractive.

This pleasing custom is due to a pious desire to shelter the Dove, a bird entirely sacred to the Virgin in Russia, and which is never molested in any way, much less killed and used for food—indeed, anyone found guilty of such an act would run the risk of serious reprisals from the neighbours.

The name Dove embraces any kind of pigeon, wild or tame, and fancy kinds are often kept as in England.

The owners of those boxes which happen to attract a Dove are greatly envied, as the privilege of harbouring and sheltering the "Virgin's Bird" is considered to entail good luck. Of course, only a small proportion of these boxes are selected by Doves; Starlings and other birds make frequent use of them, and are always welcome.

Figure 27 is from a sketch which I made of a typical box in the garden of a small house in Libau. Notice the two small perches below the entrance hole. LIONEL E. ADAMS.

FIGURE 27.
A Typical Russian Nesting-box.

PHOTOGRAPHY.

By EDGAR SENIOR.

PHOTOGRAPHING ROCK SECTIONS.—One of the most interesting, and at the same time valuable, applications of photography to the microscope, especially when considered from an educational standpoint, is its use in obtaining permanent records of geological specimens. In work of this nature, except in very few cases, low powers are all that are necessary. Although quartz, felspar, and mica form the chief constituents in rocks, the other substances which occur being of secondary importance, the sections themselves vary so much in character that the method of illumination employed in one case, may be totally unsuitable in another, so that no absolute rule can be laid down, the operator having to use his own discretion in the matter. With a little experience, however, there will be no difficulty in judging the most suitable means to employ in order to obtain the desired results. With a large number of rock sections it is necessary to make use of polarised light in order to differentiate their structure, and in some cases selenite and mica films, used either separately or in combination are an advantage also. In many cases the best results photographically are got by means of the crossed nicols only; many forms of granite are of this nature, as they give so much colour themselves that only crossed nicols are required. Others again require the selenite to show them properly. In the accompanying illustration Figure 28, which is from a section of Aberdeen granite, a red and green selenite plate was used, in order to show the structure at its best for the purpose of photography. In taking the negative, a twenty-four millimetre objective was used, with the analyser screwed into the nosepiece above it, and a two-projection ocular as eyepiece. An achromatic sub-stage condenser with its top lens removed, and the polariser fitted in below completed the whole optical arrangement, the source of illumination being a paraffin oil lamp. In order to make a correction for the so-called chemical focus of the objective, the light was filtered through an orange glass screen. It may not perhaps be apparent why this is necessary, considering the conditions under which the photographs are taken, but it has been found better in practice to do so, especially if lantern slides are going to be made from the negatives. One very essential condition above all others in order to ensure success in work of this class, is that the sections must be thin, otherwise the definition will be very seriously impaired. There should not be much difficulty in this, however, with the improved methods in use now for making sections. In taking the photographs it is advisable to bear in mind the photographic values of the colours, remembering that they have to be translated into monochrome, and that however fine the effect may be when seen in colours, the result may be totally disappointing in black and white. It therefore becomes necessary to employ plates which by falsifying the luminosities of the colours themselves produce the necessary contrast in the finished photograph. This very power becomes at times of immense value, as in objects which exhibit colours under polarized light such as plant-hairs, cotton-fibres, silk, flax, hemp, and so on, it affords a means of rendering details in structure which would otherwise be lost. In preparing slides for use, the objects should whenever possible be mounted in balsam, as the effect is much more striking than when mounted dry or in water. Then, again, the Lumière Autochrome process affords a means of producing very fine lantern slides showing the colours themselves, and when photographing in this way the compensating screen for subduing the too great action of the blue, is not required when the oil lamp is used, as the colour of the light is sufficient in itself for the purpose. It will also be found that with moderate powers the exposure is not long.

FIGURE 28.
Section of Aberdeen Granite photographed with polarized light × 70 diameters; objective employed 24 mm., together with a two projection ocular.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

DENSITY OF LIQUIDS.—While investigating the behaviour of various liquids of different densities which were sufficiently insoluble to maintain a meniscus of separation, Professor A. L. Clark finds that chloroform and water have equal density at a certain temperature. The two liquids are placed in a thick-walled capillary tube which is placed in a paraffin bath. The chloroform is denser than water at the ordinary temperature, but at a few degrees below the critical temperature (260°) the chloroform rises to the top; as the

system cools down, so the chloroform again sinks to the bottom. This experiment is similar to those devised by Mr. C. R. Darling: as, for example, with aniline and water. The solubility of the liquids in each other causes the equilibrium to become unstable and the position of the liquids to reverse, at a temperature slightly different from the temperature corresponding to equal density. Chloroform and water have different indices of refraction, but as the temperature rises the index of chloroform decreases more rapidly than that of water, and when the two indices become equal the separating surface disappears from view and gives the appearance of complete homogeneity.

THE PHOTOELECTRIC EFFECT.—When metal surfaces are exposed to ultra-violet radiations, negative electrons are expelled from these surfaces. Each metal has a definite photoelectric effect of its own. It is interesting to gain knowledge of the emission velocities of the electrons from the salts of metals and various compounds, and the work of Dr. A. Ll. Hughes supplies that information. It was necessary to experiment with surfaces of which the state of the surface is similar to the mass of the substance, because the photoelectrons come from a layer only a few molecules in thickness. This has been ingeniously effected by vaporising the substance *in vacuo* from a small quartz bulb furnace, electrically heated, on to a nickel disc lowered near the mouth of the furnace. Most halogen salts show marked photoelectric effect after exposure to light, but such substances as zinc chloride or phosphorus pentoxide show no such effect. It appears that only those substances which are decomposed by light show the photoelectric effect, and that the light first decomposes the surface and then acts on the metallic element in the ordinary way.

SILENT DISCHARGES.—In Chili, observations have been made on the "Andes glow," which appears to start from an altitude of ten thousand feet along a ridge or conical peak. Luminous arcs up to 25° in width, surrounding a dark core, or radial groups of rays shooting up as far as the zenith, were observed, and lasted for several seconds. The phenomenon is frequent on warm, clear nights.

FLICKER.—When a disc with black and white sectors is spun round at a moderate speed, a flicker may be seen; on increasing the speed the flicker disappears, but if the illumination increases the flicker may reappear if the speed is not too great. The disappearance of the flicker is connected with the speed, the intensity and hue of the illuminating light, and with certain physiological effects on the eye. Dr. T. C. Porter has investigated the connection between illumination and critical speed at which flicker vanishes, and an abrupt alteration in the relation occurs when a certain low illumination is reached, and this must in some way be connected with the behaviour of the eye. Mr. H. E. Ives has published a detailed investigation on the application of the "flicker" method to the photometric comparison of lights of different hue, a problem of considerable complexity. The relative brightness of differently coloured lights is not constant under all conditions, owing to two main physiological effects—the Purkinje effect and the "yellow spot" effect. The former is the greater sensitiveness of the eye to blue light at low illumination, and the latter is the change of relative brightness of different colours when the size of the field of view is changed and different areas of the retina of the eye are illuminated. Mr. Ives has found the reverse of these effects when experimenting with the flicker method of comparing lights of different colours. There are four methods open to the comparison of lights of different hue, viz.:—

(I) The estimation of the sensation of equal brightness.

(II) The visual acuity or the estimation of the fineness of detail detectable as the luminosity decreases.

(III) The critical frequency or the comparison of the intensity of the light illuminating discs of black and the colour at the same speed of alternation.

(IV) The "Flicker" method, when the two colours alternate and the slightest change of either at a particular speed produces "flicker."

The work of Mr. Ives will certainly lead to a method of comparing the intensity of light of different hue, but the accuracy will always be dependent on the eye of the observer to some extent.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

HOW DOES EXPERIENCE COUNT FOR THE RACE? It is certain that many animals have an inborn capacity of reacting in a definite and adaptive way to particular stimuli. We call their behaviour instinctive. In many cases it seems possible to think quite clearly about the possible origin of these inborn capacities. We can think of them *beginning* as germinal variations; we can think of them *progressing* as germinal variations; we can think of them being most subtly *perfected* in the course of Natural Selection. And all without supposing that the tutelage of experience counted for anything except in the individual lifetime. This is the ordinary Darwinian view, in contrast, for instance, to the view of Professor Richard Semon, who holds very strongly that we must suppose that the offspring directly benefit by the premiums which their parents and ancestors have paid to experience. And some of the cases of very specific instinctive reaction are so striking that one is inclined, at first sight at least, to conclude that the lessons of experience must be in some way entailed. Let us cite one case taken by Semon from Lenz's "Schlangen und Schlangenfeinde" (Gotha, 1870). Lenz took two young buzzards from the nest and reared them. They killed slow-worms and ringed snakes carelessly, but they were in a most striking way excited when they first had to deal with an adder. They had previously devoured pieces of adder's flesh quite greedily, so it could not be smell that pulled the trigger. Moreover, buzzards work by sight. Now, what was it made the buzzards treat the adder in a way entirely different from that in which they dealt with grass snakes?

VINDICATION OF THE CABBAGE FLEA.—When we turn up the well-known leaflets of the Board of Agriculture under the heading Cabbage Flea or *Haltica oleracea*, we find it stated that this little bluish-green beetle is often far more harmful than the Turnip Flea, that "in some districts it is the chief root crop and general pest," and that it "attacks old and young plants, especially cabbages, but also turnip and other crops." Now we do not wish to take up the cudgels on behalf of flea-beetles, but it is of interest to call attention to a vigorous protest by Franz Heikertinger in Vienna, who has been engaged for seven years in a study of the Palaearctic Halticinae. The cabbage flea has been grossly libelled. It frequents Polygonaceae like buckwheat and Onagraceae like willow herb. It does not frequent Crucifers, nor eat them, nor develop on them. The fact seems to be that *Haltica oleracea* has been carelessly mixed up with species of *Phyllotreta* such as *Ph. nemorum*, the turnip-flea-beetle, and with species of *Psylliodes*, such as *Ps. chrysocephala*. It is strange that the mistake should have remained so long undetected, and it is satisfactory to have it corrected. For not only should justice be done even to a flea-beetle, but it is of practical importance in agriculture, that the true culprit should be persecuted.

CTENOPHORES.—In his finely-illustrated memoir on the Ctenophores of the Atlantic coasts of North America, Mr. A. G. Mayer calls attention to the fascinating beauty of these animals. "In the extreme tenuity of their bodily substance and their diaphanous delicacy of coloration, the ctenophores stand apart from other marine animals. Their presence in the water is commonly denoted only by the brilliant flash of rainbow colours, which play along the lines of their ciliary combs as they move languidly beneath the unrippled surface of the sea. Yet these creatures are no more wonderful in their complex organization than in their remarkable adjustment to their habitat; for so delicate are most of them that a current such as that of an oar suffices to tear them into misshapen shreds—a fate which they escape in time of storm by

sinking far into the depths. This fact accounts for the extreme rarity of many of these forms, for the ocean's surface must have remained flat as a mirror for many hours before they can be lured upward from the calm of their deep retreat. Yet tender as they are to the touch, passing jelly-like between the fingers of the hand that attempts to seize them, their food consists largely of young fishes which they engulf in great numbers, seizing their prey by means of their peculiar adhesive cells. Thus, in the cold northern waters where ctenophores occur in vast swarms, they constitute a serious menace to the cod fisheries by devouring pelagic eggs and young fish."

FIVE-YEAR PEDIGREED RACE OF PARAMOECIUM.—Many facts seem to point to the conclusion that conjugation or fertilisation in Protozoa renews the vigour of the cell-lineage. Another view is that fertilisation is in some way concerned with the phenomenon of variation, or that it may enable the units to withstand changed environmental conditions. Professor Lorande Loss Woodruff has devoted many years to the experimental study of the slipper animalcule (*Paramoecium*), and one of his last papers is very interesting.

On May 1st, 1907, he started with a "wild" *Paramoecium aurelia*, isolated from an aquarium. When it had produced four individuals by division, these were isolated to four lines. The pedigreed culture has been maintained by a specimen isolated from each of these lines practically every day up to May 1st, 1912, thus precluding the possibility of conjugation taking place and facilitating an accurate record of the number of generations attained.

In the five years there were three thousand and twenty-nine generations, four hundred and fifty two in the first, six hundred and ninety in the second, six hundred and thirteen in the third, six hundred and twelve in the fourth, and six hundred and sixty-two in the fifth. The mean rate of division was over three divisions in forty-eight hours. The organisms were as healthy in 1912 as in 1907. They had given evidence of the potentiality of producing a volume of protoplasm approximately equal to 10^{1000} times the volume of the earth! This seems to show that in favourable environment there is no need of conjugation and no reason for senescence.

FILOPLUMES.—It is usual to distinguish on a bird four kinds of feathers,—the ordinary contours, the down-feathers, the half-down, and the filoplumes. The last are most familar on a plucked bird, standing up in scores on the bare body, each like a hair with a tuft at the top. Very little is known in regard to their development or their replacement, but Otto Fehringer has recently described their arrangement in a number of representative birds. They occur regularly along with contour-feathers and occasionally with down feathers. Their pits or follicles are separate from those of their companion feathers, but closely juxtaposed. If contour-feathers grow strong at one part of a feather-tract, so do the filoplumes. On the main feather-tracts, the filoplumes occur in definite relations to the contour-feathers. Thus, if the contour-feather is median and directed backwards, it has a filoplume on each side of its base; if the contour-feather is lateral and directed outwards and backwards, the filoplumes are on the median side; if the contour-feather is lateral, but directed inwards and backwards, the filoplumes are on the lateral side.

SOLAR DISTURBANCES DURING NOVEMBER, 1912.

BY FRANK C. DENNETT.

NOVEMBER has proved very unfavourable to the solar observer. Six days were too cloudy to admit of observation, and some others were too dull to yield very satisfactory results. The disc was apparently clear of disturbances, bright or dark, on thirteen days, and on eight only faculae were visible. At noon on November the 1st, the longitude of the central meridian was 90° 3′.

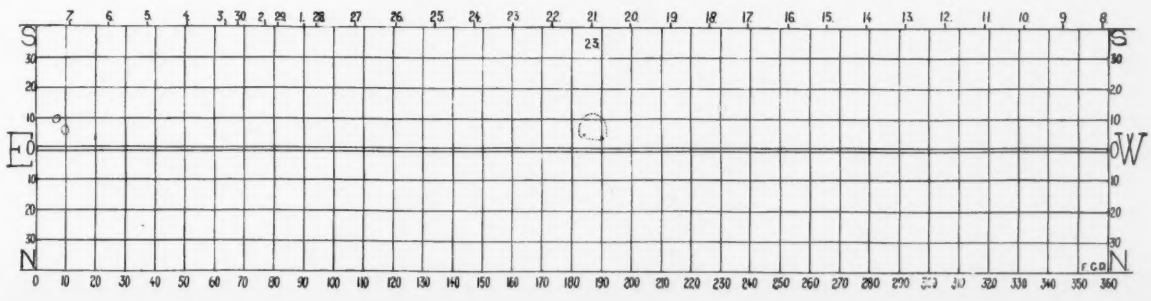
No. 23.—The only spot disturbance seen was first recorded on the 17th, the Sun not having been visible on the two previous days. At 10.45 a.m. it was described as a small very black spot having little penumbra, but followed by an elliptical faculic disturbance containing at least eight pores. A little after noon the edge of the umbra was observed to be frayed, and at the other side of the faculae were indications of a trailer or end spot. Directly eastward of the leader a dark hydrogen floculus was visible with the spectroscope, pointing towards the S.S.E., deflecting the C.-line towards red. On the 18th the group seemed little altered and when last seen, on the 19th, there appeared to be two spots, one at each end, but clouds intervened before measures could be completed.

On November the 30th there was apparently a badly-formed spot in the equatorial region near longitude 95°, with traces of pores in a rough-looking area by which it was surrounded. No measures were obtained. It was doubtless the remains of the disturbance which produced the groups of Nos. 18 and 20.

Faculic disturbances near longitude 10°, S. latitude 6° to 10°, were observed within the eastern limb, on November 1, 2, 3, and 29, and approaching the western edge on the 11th. The faculic area connected with the spot group 23, was seen as it approached the western limb on the 25th and 26th.

In the preparation of this little note the importance of combined study by observers at distant stations cannot be overestimated. Six observers at five stations so far separated as Lisburn, Manchester, Bath, Margate and Hackney, the greatest number of observations at any one station being eighteen. The observers were Messrs. J. McHarg, A. A. Buss, C. Frooms, E. E. Peacock, W. H. Izzard, and the writer.

DAY OF NOVEMBER, 1912.



THE FACE OF THE SKY FOR FEBRUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Feb. 5	21 14·3	S.16·0	20 47·4	S. 22·3	20 54·3	S. 19·6	0 8·8	N. 1·6	18 31·8	S.23·1	3 41·6	N.17·7	7 43·4	N.20·8
,, 10	21 34·3	14·4	0 26·8	N. 3·3	21 29·6	17·0	0 27·1	4·2	18 36·1	23·0	3 42·0	17·7	7 42·8	20·8
,, 15	21 53·9	12·8	4 31·0	N.26·7	22 4·4	13·9	0 44·9	6·6	18 40·4	23·0	3 42·5	17·8	7 42·3	20·9
,, 20	22 13·2	11·0	9 45·6	N.17·1	22 39·2	10·1	1 2·0	9·0	18 44·4	22·9	3 43·3	17·8	7 41·9	20·9
,, 25	22 32·3	S. 9·2	14 14·2	S. 16·6	23 13·2	S. 6·0	1 18·3	N.11·3	18 48·3	S.22·8	3 44·2	N.17·9	7 41·4	N.20·9

TABLE 1.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Saturn. P	Saturn. B
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.	°	°
Feb. 5	−13·9	−6·4	265·3	−14·6	−4·3	−2·0	312·2	192·9	11 8 *e*	4 36 *e*	−2·3	−24·2
,, 10	15·8	6·6	199·5	−21·8	4·7	2·0	21·3	223·5	1 34 *m*	5 50 *m*		
,, 15	17·5	6·9	133·7	− 8·0	5·1	2·0	90·3	254·2	7 22 *e*	2 55 *e*	2·3	24·3
,, 20	19·1	7·1	67·8	+18·2	5·6	1·9	159·1	284·9	7 39 *m*	2 4 *e*		
,, 25	−20·6	−7·2	2·0	+18·1	−6·0	−1·9	227·9	315·7	3 36 *e*	3 17 *m*	−2·4	−24·4

TABLE 2.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zone, T_1, T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues his Northward march. Sunrise during February changes from 7–44 to 6–51; sunset from 4–43 to 5–35. Its semi-diameter diminishes from 16′ 15″ to 16′ 10″.

MERCURY is a morning star till February 11th, then an evening star. Illumination, full at beginning of month, four-fifths at end.

VENUS is an evening Star, approaching its greatest elongation, which it reaches on February 12th. Illumination one-half, semi-diameter $12\frac{1}{4}''$. The planet is very favourably placed for observation by Northern observers.

THE MOON.—New $6^d\ 5^h\ 22^m m$; First Quarter $14^d\ 8^h\ 34^m m$; Full $21^d\ 2^h\ 3^m m$; Last Quarter $27^d\ 9^h\ 15^m e$. Apogee $7^d\ 8^h m$, semi-diameter 14′ 43″; Perigee $20^d\ 12^h e$, semi-diameter 16′ 47″. Maximum Librations, 2^d 7° N., 14^d 8° E., 17^d 7° S., 27^d 7° W. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

Date.	Star's Name.	Magnitudes.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913.			h. m.		h. m.	
Feb. 1 ...	BAC 5737	6·7	—	—°	5 30 *m*	285°
,, 2 ...	γ^1 Sagittarii	var.	6 46 *m*	144	7 40 *m*	227
,, 14 ...	BD+24°599	6·6	7 44 *e*	95	—	—
,, 17 ...	47 Geminorum	5·6	11 11 *e*	155	11 55 *e*	235
,, 17 ..	BD+27°1337	6·8	11 41 *e*	44	—	—
,, 18 ...	BAC 2383	6·5	1 28 *m*	110	2 25 *m*	283
,, 18 ...	ω^2 Cancri	6·2	4 12 *e*	45	4 47 *e*	329
,, 19 ...	BD+21°1969	7·7	5 0 *e*	67	—	—
,, 21 ...	χ Leonis	4·7	6 13 *e*	122	7 6 *e*	289
,, 22 ...	80 Leonis	6·4	5 45 *m*	146	6 36 *m*	277
,, 25 ...	BAC 4682	6.5	5 59 *m*	74	6 49 *m*	339
,, 26 ...	BAC 4923	5·7	4 46 *m*	69	5 38 *m*	343
,, 27 ...	δ Scorpii	4·7	4 21 *m*	188	4 41 *m*	219

TABLE 3. Occultations of stars by the Moon visible at Greenwich.

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

MARS is a morning Star, but practically invisible.

JUPITER is still badly placed, having been in conjunction with the Sun on December 18th. It is, however, just coming into view as a morning star. Polar semi-diameter, $15\frac{1}{2}''$.

Day.	West.	East.	Day.	West.	East.
Feb. 1	3 ○	214	Feb. 15	3 ○	$\frac{1}{2}$ 4
,, 2	$\frac{3}{2}$ 1 ○	4	,, 16	321 ○	4
,, 3	⊙	234	,, 17	2 ○	14 3●
,, 4	○	1423	,, 18	1 ○	234
,, 5	$2\frac{1}{4}$ ○	3	,, 19	2 ⊙	34
,, 6	42 ○	31	,, 20	2 ○	134
,, 7	431 ○	2	,, 21	$\frac{1}{3}$ ○	$\frac{2}{4}$
,, 8	43 ○	21	,, 22	34 ○	12
,, 9	4321 ○		,, 23	4321 ○	
,, 10	4 ○	$\frac{3}{1}$ 2●	,, 24	42 ○	1 3●
,, 11	4 ○	23 1●	,, 25	41 ○	$\frac{3}{2}$
,, 12	$4\frac{1}{2}$ ○	3	,, 26	4 ⊙	13
,, 13	24 ○	13	,, 27	42 ○	13
,, 14	31 ○	24	,, 28	$4\frac{1}{3}$ ○	2

TABLE 4.

Configurations of Jupiter's satellites at 6^h *m* for an inverting telescope.

Satellite phenomena visible at Greenwich, $1^d\ 6^h\ 24^m$ II. Sh. I.; $3^d\ 5^h\ 48^m$ I. Tr. I.; $7^h\ 19^m$ I. Sh. E.; $10^d\ 6^h\ 56^m$ I. Sh. I; $11^d\ 7^h\ 17^m$ I. Oc. R.; $17^d\ 5^h\ 43^m$ III. Oc. D.; $6^h\ 31^m\ 3^s$ II. Ec. D.; $18^d\ 6^h\ 3^m\ 34^s$ I. Ec. D.; $19^d\ 5^h\ 34^m$ I. Sh. E.; $5^h\ 43^m$ II. Tr. E.; $6^h\ 33^m$ I. Tr. E.; $24^d\ 5^h\ 58^m\ 27^s$ III. Ec. D.; $26^d\ 5^h\ 11^m$ I. Sh. I.; $5^h\ 42^m$ II. Tr. I.; $6^h\ 14^m$ I. Tr. I.; $6^h\ 19^m$ II. Sh. E.; $27^d\ 5^h\ 45^m$ I. Oc. R.

All the above are in the morning hours.

Attention is called to the simultaneous transits of I. and II. on the 19th and again on the 26th.

SATURN is an evening Star, 6° South of the Pleiades. Polar semi-diameter $8\frac{1}{2}''$. The major axis of the ring is 43″, the minor axis $17\frac{1}{2}''$. The ring is now approaching its maximum opening and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). February $2^d\ 6^h{\cdot}4\ m$, $9^d\ 7^h{\cdot}7\ e$, $17^d\ 9^h{\cdot}0\ m$, $24^d\ 10^h{\cdot}2\ e$. Dione (every third given). February $5^d\ 7^h{\cdot}8\ m$, $13^d\ 0^h{\cdot}9\ e$, $21^d\ 6^h{\cdot}0\ e$. March $1^d\ 11^h{\cdot}\ 2e$.

Rhea (every second given). February $1^d\ 2^h{\cdot}8\ e$, $10^d\ 3^h{\cdot}7\ e$, $19^d\ 4^h{\cdot}7\ e$, $28^d\ 5^h{\cdot}7\ e$.

For Titan and Iapetus, E. W. mean East and West elongations, I. S. Inferior and Superior Conjunction, Inferior being to the North, Superior to the South. Titan, $3^d\ 4^h{\cdot}8\ e$ I., $7^d\ 0^h{\cdot}9\ e$ W., $11^d\ 0^h{\cdot}0\ e$ S., $15^d\ 3^h{\cdot}4\ e$ E., $19^d\ 4^h{\cdot}0\ e$ I., $23^d\ 0^h{\cdot}4\ e$ W., $26^d\ 11^h{\cdot}6\ m$ S. Iapetus $19^d\ 8^h{\cdot}9\ e$ I.

URANUS is invisible, having been in conjunction with the Sun on January 24th.

NEPTUNE was in opposition on January 14th. Its motion may be traced on the map of small stars which was given in "KNOWLEDGE" for December, 1911, page 476.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Feb. 5—10	75°	+ 41°N	Slow, bright.
,, 15 ...	236	+ 11 N	Swift, streaks.
,, 15 ...	261	+ 4 N	Swift, streaks.
,, 20 ..	181	+ 34 N	Swift, bright.
,, 20 ...	263	+ 36 N	Swift, streaks.

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 6^h to 10^h, next month 8^h to 12^h, and so on. In the case of Algol variables, the time of one minimum is given where possible, and the period. Algol, owing to its brightness, will be given for wider limits.

Star.	Right Ascension. h. m.	Declination.	Magnitudes.	Period. d. h. m.	Date of Minimum. d. h. m.
Algol	3 2	+40°·6	2·3 to 3·4	2 20 49	Feb. 2 6 27 *e*
RW Monocerotis	6 30	+ 8 ·9	9 to 10·5	1 21 45	
RX Geminorum	6 44	+33 ·3	8·5 to 9·5	12 5 0	
RU Monocerotis	6 50	− 7 ·5	9·5 to 10·5	0 21 30	
R Canis Maj.	7 15	−16 ·2	6 to 6·5	1 3 16	Feb. 6 8 38 *e*
RY Geminorum	7 22	+15 ·8	8·5 to 10·5	9 7 13	
Y Camelop	7 29	+76 ·3	9·5 to 12	3 7 20	
RR Puppis	7 44	−41 ·2	9·5 to 10·5	6 10 19	
V Puppis	7 56	−49 ·0	4 to 5	1 10 54	Feb. 7 10 24 *e*
X Carinae	8 29	−58 ·9	7 8 to 8·6	0 12 59·6	Feb. 2 0 36 *e*
S Cancri	8 39	+19 ·4	8·2 to 9·8	9 11 38	
S Velorum	9 30	−44 ·8	7·8 to 9·3	5 22 24·4	
Y Leonis	9 32	+26 ·7	9·0 to 10·6	1 16 28	
W Urs. Maj.	9 38	+56 ·4	7·9 to 8·7	0 4 0·2	

TABLE 5.

Of long period variables *o* Ceti (Mira) will reach a maximum at the end of April, when it will be invisible in the sunshine, but it may be seen brightening early in the year.

REVIEWS.

ASTRONOMY.

The Sun.—By CHARLES G. ABBOT, of the Smithsonian Institution. 448 pages. Numerous illustrations. 8-in. × 5-in. (D. Appleton & Co. Price 7/6 net.)

The publication of this treatise is indicative of a most healthy change that is coming over astronomy. All through it exhibits an able attempt to explain phenomena, to correlate and to classify observations. A dynamical deduction that furnishes a clear explanation even if not the final word on the subject is of value. It is said that truth more easily arises from error than from confusion. Attempting to observe with-

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out a working hypothesis is like building without a scaffold, yet it is not many years ago since an eminent astronomer said that we do not want theory, we want facts. The promise of the preface is well sustained. In it the author says that the time seems ripe for collecting the splendid array of new solar knowledge which such unprecedented activity has produced, and for discussing the probable nature of the Sun in the light gained. All this he has done most admirably.

There are other explanations and generalizations that he has evidently not read, hence he has not given us the whole truth. He has, however, examined many obsolete explanations, in the light of modern chemistry and physics and has shown them to be wrong, such as the Laplace ring theory, and the carbon cloud theory of the photosphere. This is especially good work: we do not want false explanations to fossilize into supposed firm fact, no matter how beautiful the errors may be. The author argues conclusively that the photosphere is a gaseous surface, but he does not seem to be aware that it is almost certainly the limit of static equilibrium, all above it being supported by kinetic energy; the supporting power of the reversing layer being the energy of volcanic projection, and that of the chromosphere being molecular kinetic energy. Nor does he seem to realize that if meteors have anything to do with sunspots their function is probably similar to the detonator of a dynamitic explosion. Meteors are, as it were, the triggers, the dynamical rigidity of the Sun supplying the effective energy. Altogether this is a great book, fearless in the expression of new ideas, and intensely sane in their advocacy. It will do much to render solar information available, instead of remaining a lumber of uncorrelated facts.

A. W. B.

The Star Calendar for 1913. With Revolving Chart.—By MRS. H. PERIAM HAWKINS. 10-in.×10-in.

(Simpkin, Marshall & Co. Price 1/- net.)

Users of this chart will find it one of the very best forms of planisphere yet designed. The area of the heavens visible at any time is shown by an oval cut in a covering card. Hence the zenith can be recognised at once. This card is hinged at the top, so that it can be lifted to see the whole of the stars ever visible in England.

The chart has proved itself of great value to troops who are studying marching by the stars. The explanations of how to use it are very clearly described.

It would be an improvement were the North Polar Circle drawn to show precession, and also were the Milky Way indicated by a faint whiteness.

This is a most useful chart, and can be highly recommended.

A. W. B.

The Star Almanac, for 1913.—By MRS. PERIAM HAWKINS. 6 illustrations. 30-in.×24-in.

(Simpkin, Marshall & Co. Price 6d. net.)

Again Mrs. Periam Hawkins has introduced improvements into this excellent Almanac. In addition to the star charts for the four seasons, there is a diagram showing the North Polar clock. She has also brought in a table of hints in connection with marching and telling the time by the stars, the sun, and the moon. There is all the usual information contained in a star almanac.

The Almanac would be most valuable on the walls of any astronomer's study or observatory.

A. W. B.

The A.B.C. Guide to Astronomy. Second Edition. By MRS. H. PERIAM HAWKINS. 120 pages. 7½-in.×5-in.

(Simpkin, Marshall & Co. Price 1/6 net.)

This little book is of the kind one is glad to see in its second edition, for it is a very valuable contribution to Astronomy. The first edition had a few misprints and slight errors from which this edition seems quite free, as one would expect after it had passed the keen eye of so able and accurate an astronomer as Dr. A. C. D. Crommelin. Mrs. H. Periam Hawkins must have read very widely in preparing this book, for there is scarcely an astronomical idea of importance the meaning of which is not described with the utmost clearness.

The information is brought quite up to date. Good abstracts of the latest correlations are given, some of which are seldom seen in any astronomical work. This attention to broad generalizations is of the utmost importance in these days, when the mass of detail accumulated by astronomers threatens to bury the essential facts out of sight. The A.B.C. arrangement is also very useful in the case of points needing reference. The book is strongly to be recommended to the amateur astronomer.

A. W. B.

A Primer of Astronomy.—By SIR ROBERT BALL. 222 pages. Numerous maps and illustrations. 7-in.×4½-in.

(The Cambridge University Press. Price 1/- net.)

This excellent little book has its value much increased in its re-issue, by the addition of maps of the northern and southern hemispheres, and by a new chapter of forty-two pages on celestial objects. This chapter is written in Sir Robert Ball's usual perspicuous style. It is exactly suited to the amateur observer, every interesting object in both northern and southern hemispheres being very fully described. The book is thus rendered suitable to Africa and Australia. The descriptions are brightened by interesting folklore. In the older parts of the book one could have desired a few alterations to bring it up to date. For instance, in the nebula of Andromeda, which is described as showing rings elongated by projection into ellipses, while the latest photographs leave no room to doubt its spiral character. Some of the explanations are also a little antiquated, and not quite in accord with modern chemical physics.

A. W. B.

A Beginner's Star-Book.—By K. MCKREADY. 148 pages. 70 maps and illustrations. 10½-in.×8-in.

(G. P. Putnam's Sons. Price 9/- net.).

The author says in his Preface that this book is "in a sense but one effort more to help those who are without technical equipment, to claim through the unaided eyes or through simple optical instruments their heritage in things of the sky"; "It is intended for the general reader," and not as a text book, but "as a simple observational manual," and, further, "The volume is also intended for those who wish to add to their knowledge of the skies without aid of any kind" . . . . "much of it is, necessarily, a recapitulation of elementary facts; it is frankly a book for the beginner." These extracts adequately explain the nature of this work and we heartily congratulate the author in having so successfully accomplished what he set himself to do. We are acquainted with most books of this nature or aim published during the last forty years, but we cannot recall the title of one that so well fills the need of an elementary and *progressive* book on observational astronomy for the beginner, young or old. Most err in being either too easy or simple without the redeeming feature—given in this book—of opportunities for promoting or satisfying advancing knowledge; too technical, too profuse or laborious for the convenient and daily use of a beginner in out-door astronomy; or too much out of date to meet the recent advances even in observational astronomy. To us this book appears to be the bridge.

Beyond the data or details in the book being brought up-to-date there can be little that is new, nor does the author claim that it is so. The principles of the book are to encourage the beginner to learn from the *objects*, not from mere book reading; to proceed slowly, get a good grasp of one thing at a time, and not to attempt too much at once.

The book of one hundred and forty-eight pages is divided into ten chapters or divisions: I, Introduction, brief but very useful; II, Objects to be seen. The Stellar World; III, Learning to observe; IV, Star maps; V, Objects to be seen. The Solar System; VI, Some Instruments of Observation; VII, An Observer's Catalogue of Telescopic Objects; VIII, Statistical

Tables of Star Distances, and so on; IX, Index, quite good; X, Additional maps.

The whole-page illustrations of Stellar objects are numerous and are scattered through the chapters. The selection of those relating to nebulae has been judicious, representing many of the most striking and well-known types; as the photographs have been excellently reproduced from the unsurpassed photographs made at the Yerkes Observatory, it is almost needless to say that they are of the best. The night star-maps from pages 38 to 61 are given both in black and white stars on opposite pages, and below each map is added much information for use without and with small instrumental aid. The chief features of the Sun, Moon, Planets and Comets are given, also with plates from photographs taken at the Mount Wilson, Lowell and Lick Observatories. Chapter VII consists of an alphabetical description of the Constellations, proper names and their pronunciation; much useful and accurate information has been provided in a small space of twenty-one pages: Webb, Smyth, Ambronn and Harvard Observatory books have been utilized in forming the catalogue. This chapter is followed by another containing lists of distances of double and of variable stars, also the photometric magnitudes of the seventy brightest stars; and at the end is a summary or list of books useful to an astronomical observer. We do not think this portion is so replete with information as the other portions of the book; we notice that a number of most useful elementary and general books on Astronomy of recent publication are omitted.

For such a book of information and excellent illustrations the price is quite moderate. There is one objection to the book, and that is the highly-surfaced coated paper upon which the text is printed.

F. A. B.

Their Winged Destiny: being a Tale of Two Planets.—By D. W. HORNER. 240 pages, with a frontispiece, 7¼-in. × 5-in.

(Simpkin, Marshall & Co. Price 2/- net).

This is a book of convenient size for the pocket, being nicely printed with good-sized type and on rough laid paper. The author need hardly have remarked in his preliminary note that the narrative was purely imaginary. The tale reminds us of our Jules Verne days. Certain definite scientific facts—this time the airship—are carefully worked in with the author's imagination "run-riot." Sudden difficulties arise and they are just as quickly and easily overcome. A journey is made in the airship to an unknown planet and the return to the Devonshire moors is accomplished in the thirty-third chapter,—some of the more useless members of the party having been left behind on the planet,—when the happy end is achieved in the marriage of the airman and the once little girl.

F. A. B.

Notes on the use of the Portable Reversible Transit Instrument.—By C. E. MONRO. 60 pages, 2 Plates, 8 Figures. 8-in. × 5-in.

(J. D. Potter. Price 3/-.)

The author made good use of his time by recording notes when he was at the Royal Observatory, Greenwich, learning the practical use of a transit instrument for the purpose of longitude determinations. These notes, supplemented by later experience when at Ascension, form the basis and body of this useful little hand-book. The author states that the book is "intended purely for the use of beginners."

Chapters I–IV. form nearly half the book and deal with the description and principle of the instrument in considerable detail, also with its level and mounting. Chapter V. is concerned with the method of observation. Chapter VI. relates to the reduction of the observations; this chapter with appendices II to V. constitutes the most important part of the book; the forms and methods of reduction are those in use at Greenwich. A theoretical explanation of the reduction of transit observations is given in Appendix I. There are two plates and eight diagrams to aid the explanations. Pages three and four contain a good index. The author expresses his great indebtedness and gratitude to Mr. H. P. Hollis for his valuable help in instruction, in suggestions, and in the revision of the manuscript. This is a book that all who are interested in transit and time observations should possess.

F. A. B.

CHEMISTRY.

Modern Research in Organic Chemistry.—By F. G. POPE, B.Sc. (Lond.) 324 pages. 261 illustrations. 7¼-in. × 4¾-in.

(Methuen & Co. Price 7/6.)

In no branch of chemistry has greater advance been made through the application of pregnant hypotheses, than in the study of the compounds of carbon. Until about half a century ago all was confusion, and it was not until the theory of organic radicles had been proved workable that order began to develop out of an accumulated mass of apparently unrelated details, and that organic chemistry was shown to be as capable of systematic treatment as was the inorganic branch of the science. The series of brilliant researches which laid the foundations of the structural formulae of carbon compounds formed another stage in the advance, and now we have reached the stage of establishing the relationship between physical properties and the structure of different bodies.

All these successive steps in the development of organic chemistry are sketched in an interesting preface to the book, by Dr. J. T. Hewitt, and this forms a fitting introduction to the subjects of which the text treats.

The book is conveniently divided into chapters dealing with the work that has been done in connection with different classes of compounds, such as the polymethylenes, terpenes and camphors, the uric acid group, and the alkaloids. There is also an interesting chapter upon the relationship between colour and the constitution of chemical compounds. Although much work has been done in this direction, there are still numerous instances where no such relationship has been discovered. In the author's opinion, however, it is not improbable that even in such cases as these further investigation may show that certain molecular groupings are associated with the particular vibrations giving the impressions of certain colours.

Research will also probably prove fruitful in establishing a relationship between physiological properties and chemical constitution, and in a future edition of the book a chapter upon this aspect of the subject might with advantage be added.

The work is well illustrated with diagrams, and, as is essential in a book of the kind, gives full references to the original papers. It is not intended to be an elementary text book, but to the research student it should prove an invaluable companion.

C. A. M.

Industrial and Manufacturing Chemistry (Organic).—By GEOFFREY MARTIN, Ph. D., M. Sc. Assisted by Specialists. 726 pages. 249 illustrations. 10-in. × 6½-in.

(Crosby Lockwood & Son. Price 21/- net.)

The name of Dr. Martin will be familiar to the readers of "KNOWLEDGE," and its occurrence on the title-page of a book is of itself presumptive evidence that the work will be interesting and well written.

The aim of this book is quite different from that of Allen's "Organic Analysis," for its object is to give a clear outline of the numerous manufacturing processes based upon organic chemistry, together with some details of the methods used in the examination of the different products—sufficient to follow the meaning of an analytical report, though not for the making of an analysis.

The extent of ground covered may be gathered from the fact that it deals with industries as far apart as the making of soap and the brewing of beer, or the manufacture of artificial perfumes and the preservation of timber. Chemistry is now so much a matter of specialisation that no man can hope to have a thorough knowledge of more than one or two branches, and the chief author and editor has therefore very

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wisely availed himself of the assistance of specialists in the different subjects, while at the same time keeping the general style and arrangement the same throughout the book.

In the case of each industry there is not only a clear description of the manufacturing processes with illustrations of modern apparatus, but outlines are also given of methods suggested by recent patents. Full references to the scientific literature are also placed under each section, so that the book must prove of great assistance to the manufacturers, patent agents, and students engaged in industrial research, as well as being of interest to the general reader. We notice that in the section upon vinegar, the editor acknowledges his indebtedness to an article that appeared in "KNOWLEDGE" as the source of his most recent information.

It is perhaps invidious to single out any particular sections, but the chapter on Synthetic Rubber, by Dr. Martin, and that on the manufacture of Synthetic and other Drugs, by Dr. Challenger, deserve mention as being particularly good. In some of the sections however, there are indications that the writer has a general rather than a special knowledge of his subject, although for the reason mentioned above this was probably inevitable.

It is surprising how few organic industries have escaped notice, as the present reviewer has found by test references to the excellent index. The manufacture and valuation of artificial organic manures, however, ought certainly to find a place in a treatise of this kind, and the modern processes of treating roads for the prevention of dust, with their advantages and drawbacks would form another useful section. Considering the enormous amount of matter in the book the misprints are very few, and are mainly slips of a single letter. "Zoological" for "zoogloeal" however, on page 316, is an amusing example of a printer's interpretation of a word that was new to him.

C. A. M.

A Second Year Course of Organic Chemistry for Technical Institutes.—By F. B. THOLE, B.Sc. (Lond.). 186 pages. 7¼-in.×4¾-in.

(Methuen & Co. Price 2/6.)

This little manual, which is in continuation of one that has already appeared in the same series, deals mainly with the chemistry of the carbocyclic, or (as they are more generally termed), the aromatic compounds. As in the case of Part I., the book is simply and clearly written, and although primarily intended for students in technical colleges it should be found useful by all who are not far advanced in the study of organic chemistry. The latter part of the book contains sections dealing with practical work, including an excellent scheme of qualitative analysis, but we venture to think that some experimental work should have been incorporated with the theoretical part. A very good feature is the description of special reactions, which in many text books are merely alluded to under the names of their discoverers, it being assumed that the reactions themselves are common knowledge. French text books are the worst offenders in this respect, but the fault is not uncommon in elementary English books.

C. A. M.

GEOLOGY.

Dana's Manual of Mineralogy. — By W. E. FORD. Thirteenth Edition. 460 pages. 357 figures. 10 plates. (7½-in.×5-in.)

(J. Wiley & Sons. Price 8/6 net.).

This is a revised and rewritten edition of Dana's famous manual, first published in 1848. It is now, however, twenty-five years since the text was last revised. Whilst the figures and text are new, the original scope and character of Dana's book remain, and it appeals to the same constituency as heretofore. The chapter on petrography has been omitted and for it is substituted a brief and general description of the principal rock-types. The opening section on crystallography is up-to-date, and is illustrated by much better figures than are usual in these text-books. This is followed by an account of the other physical characters and the chemical characters of minerals. The treatment of determinative mineralogy is rather full and renders the book of particular value to miners and prospectors. In the descriptive section, occupying the greater part of the book, the minerals are taken according to the usual chemical classification and are treated with regard to their chemical composition, crystallisation, general physical properties, occurrence, and use. This section is illustrated by many fine photographic plates of mineral groups, and is concluded by a long and elaborate set of determinative tables. A notable misprint is "Crypiocrystalline" for "Cryptocrystalline" in a heading on page 176, otherwise the book is very free from typographical errors.

The section on Rocks in connection with rock-making minerals would have been better for revision by a competent petrologist. Such a mistake as the inclusion of anorthosite as a variety of syenite might then have been avoided. Possibly this is due to the megascopic mode of treatment under which an anorthosite might be regarded as a "syenite" since it is built mainly of light-coloured felspars.

G. W. T.

On the Origin of the Himalaya Mountains. Professional Paper—No. 12. Survey of India.—By COLONEL S. G. BURRARD, R.E., F.R.S. 26 pages. 11½-in.×8-in.

(The Survey of India, Calcutta.)

This is a concise and valuable presentation of the geodetic evidence bearing on the origin of the Himalayas, whether the accompanying geological theory of the author be accepted or not. The plumb-line observations in the vicinity of the Himalayas shew an extraordinary deficiency of mass under the Gangetic alluvial belt immediately south of the mountains. The deflection of the plumb-line is much greater than if the Himalayas were exercising the whole of their attraction uncompensated. This line of low density is supposed to be due to a deep invisible trench or channel buried beneath the alluvium of the Ganges.

Colonel Burrard believes that in this region the sub-crustal shell has cracked, and its northern portion has then shrunk and moved away from the southern, giving rise to the folding of the Himalayas. He explains the observed fact that the folds are clearly overthrust to the south by saying that there is only an apparent movement of the upper part of the folds to the south. The real movement has been that of the under-part of the folds to the north. This, of course, contradicts the views of such distinguished geologists as Hayden, Griesbach, and Suess, who believe that the Himalayan mountain folds are due to horizontal thrust from the north against the immobile buttress of Peninsular India.

Whether Colonel Burrard's ingenious theory will be accepted by geologists depends largely on further geological evidence. It seems difficult to account for the enormous quantity of alluvium that would be necessary to fill the postulated rift, and further evidence of the depth of the Gangetic alluvium is needed. Also, should we not expect similar rifts in front of the other great folded mountain ranges of the earth?

G. W. T.

The Structure of the Earth.—By Professor T. G. BONNEY, D.Sc., F.R.S. 94 pages. 6½-in.×4½-in. (The People's Books).

(T. C. & E. C. Jack. Price 6d.)

It is a difficult feat to compress the story of the earth into the small scope of a volume of this size, but Professor Bonney has achieved the apparently impossible with remarkable success. Considering the limitations of space under which the book labours the resumé of geological science is fairly complete. The work of rain, rivers, snow, ice, and the sea, and their part in shaping the surface of the earth as we now know it, is treated in broad outline, with a necessary avoidance of detail. Volcanoes, earthquakes, land movements, and finally the history of life upon the earth, are treated in the later chapters. As a simple, concise account of geology up to date this small book may be recommended to beginners in the science.

G. W. T.

The Building of the Alps.—By Professor T. G. BONNEY, D.Sc., F.R.S. 384 pages. 32 plates. 16 figures. 9-in. × 6-in.
(T. Fisher Unwin. Price 12/6 net.)

From an early period, the many problems of Alpine rocks, snowfalls and ice-streams, have attracted men of science, especially geologists; and Professor Bonney in this book, which is the fruit of almost yearly Alpine wanderings over a period of forty-five years, shews that he is a worthy successor of the great line of de Saussure, Perraudin, de Charpentier, Agassiz, Forbes, and Tyndall. A list of his thirty-five journeys in the Alps is given in an appendix, along with the titles of no less than forty-six original papers dealing with Alpine physiographical and petrological questions.

A large part of the book, however, is really a non-technical account of Alpine geography, although purely geological matter occupies the first few chapters. In addition to descriptions of Alpine rocks and broad tectonic features, there are interesting sections on Alpine meteorology, avalanches, floods, fauna and flora, and the Alps in relation to man. The last chapter, entitled "Fifty Years of Change" gives racy reminiscences of the discomforts of travel in the Alps in the early days.

Professor Bonney's name is identified with strongly-marked views on certain controversial questions, especially in regard to the origin and age of Alpine schists, and the efficiency of ice as an eroding agent. In regard to the latter he holds and has defended in vigorous controversy the conservative and minority view that the work of ice is not more than abrasive, and is only erosive in peculiarly favourable situations. A clear account of the dispute is given in the present volume.

This entertaining book would be the better for a topographical and geological map of the Alps, without which it is hard to follow the descriptions of the first part. G. W. T.

Rough Stone Monuments and their Builders.—By T. ERIC PEET. (Harper's Library of Living Thought). 172 pages. 3 plates. 22 figures. 7-in. × 4½-in.
(Harper & Brothers. Price 2/6 net.)

This is a description in clear and simple language of the great megalithic monuments which strew the seaward parts of Europe, Asia, and North Africa. These are of perennial interest, and in times past have given rise to curious conjectures as to their origin, the agency of fairies, virgins, witches, dwarfs, devils, saints, druids, and even historical personages, being frequently invoked. These monuments range from the great structures like Stonehenge, and the even more elaborate *nuraghi* of Sardinia, and the temples of Malta, to simple standing stones (menhirs), rock-tombs, and the barrows that stud the English downs. The author has woven his description of these structures, and their mode of erection, into a most fascinating narrative, along with fact and conjecture as to the remote civilization by which they were erected. He adopts the theory that the monuments are due to a single race, whose style of building was brought to different countries in the course of a great migration or series of migrations, and finds confirmation in the remarkable fact that in geographical distribution these monuments occupy a vast seaboard, including the Mediterranean coast of Africa and the Atlantic coast of Europe. That is, they lie entirely on a natural sea route, which would be followed by a migrating race in preference to the more difficult land routes.

The book will be useful alike to the scientific archaeologist and to the interested "popular" reader. It is written in an attractive literary style, and is well illustrated. The only slips noticed are that on page 10 megalithic monuments in Italy are said to be confined to the south-east corner of the peninsula, and on page 76 to the south-west corner; and a "to" is substituted for "of" on page 59. G. W. T.

METEOROLOGY.

Weather Science.—By R. G. K. LEMPFERT, M.A. The People's Books No. 17. 94 pages. 15 illustrations. 6½-in. × 4½-in.
(T. C. & E. C. Jack. Price 6d. net.)

The seeker of knowledge on the processes involved in our varied weather will find in the above work, a review of the salient features of the Science and the principles underlying the frequent changes to which our Islands are subject. The author is the Superintendent of the Forecast Division of the Meteorological Office. W. C. J.

PHOTOGRAPHY.

Nature Photography.—By STANLEY C. JOHNSON, M.A. 115 pages. 11 illustrations. 7-in. × 4¾-in.
(Hazell, Watson and Viney. Price 1/- net.)

Mr. Stanley C. Johnson takes excellent natural history photographs himself, and it is to be expected that from his experience he could give help to others. We are not disappointed, for in his little book in *The Amateur Photographer* Library, he gives a great many valuable hints with regard to apparatus, and to photographing river and pond life, as well as small creatures to be found in the garden; while he touches on the subject of birds, which, perhaps, is the one which has attracted the attention of photographers to the greatest extent. Mr. Johnson alludes to the interest which may be obtained from photographing birds in gardens, and speaks of the usefulness, in attracting them, of the Selborne Society's nesting boxes which he has put up. If we may suggest one correction, it is that in a second edition, the words "protective coloration" be used instead of "protective mimicry" for cases in which creatures are like their surroundings. Mimicry, in its technical sense, means the special resemblance of one creature to another. There are some useful miscellaneous notes and a calendar with suggestions as to what work may suitably be done in the various months. W. M. W.

PHYSICS.

Junior Sound and Light.—By R. W. STEWART, D.Sc., and JOHN SATTERLY, D.Sc. 227 pages. 129 illustrations. 7-in. × 5-in.
(The University Tutorial Press. Price 2/6.)

This book contains a condensed account of the rudiments of "Sound" and "Light," together with numerous examples and experiments. The descriptions are clear, and the book is handy and admirably adapted for use in schools. A. C. E.

Elementary Chemical Theory and Calculations.—By JOSEPH KNOX, D.Sc. 103 pages. 7½-in. × 5-in.
(Gurney & Jackson. Price 2/- net.)

This work is only intended to be used with a textbook of systematic chemistry. The theoretical matter usually included in an elementary course, is fairly well covered; the theory is presented with the problems, which will therefore make the book a valuable aid to the teacher, who often finds some difficulty in making the somewhat long arguments, which establish the formula or the atomic weight of a substance, quite clear to the student. A. C. E.

ZOOLOGY.

Wild Life in the West Highlands.—By CHARLES HENRY ALSTON. 271 pages. 9 illustrations. 8½-in. × 5½-in.
(James Maclehose & Sons. Price 6/- net.)

This book consists of a number of articles, some of which have been reprinted from *The Scotsman* and deal principally with mammals and birds. They are very interesting reading but do not contain very much new material. W. M. W.

The Marine Mammals in the Anatomical Museum of the University of Edinburgh.—By SIR WILLIAM TURNER, K.C.B. 207 pages. 17 plates. Over 100 figures. 9-in. × 5¾-in.
(Macmillan & Co. Price 6/- net.)

It is a very great advantage to students to know where specimens are to be seen which illustrate any particular work in which they may be engaged. The title of this book speaks for itself and its value is obvious. The introduction is interesting because it tells of the history of the study of Marine Mammals in Scotland and gives hints as to differentiating the various forms. There is a large number of illustrations, the great majority of which are embodied in the text at the exact place where reference is made to them, and hence they are not provided with underlines. W. M. W.

XUM

SYNTHETIC RUBBER.*

By GEOFFREY MARTIN, PH.D., M.Sc., B.Sc.

Lecturer on Chemistry at Birkbeck College, London.

Author of "Practical Chemistry," "Triumphs and Wonders of Modern Chemistry," "Industrial and Manufacturing Chemistry," "Researches on the Affinities of the Elements," etc., etc.

THE commercial production of artificial or synthetic rubber is undoubtedly the most important problem, from a financial standpoint, ever faced by the chemical industry. Compared with it such triumphs as the successful manufacture of artificial indigo, alizarin or camphor become quite small affairs.

For example, the total value of synthetic indigo annually produced at the present time does not exceed two million pounds; and the value of all the coal-tar dyes annually exported by Germany only amounts to ten million pounds.

The world's production of such an important chemical as sulphuric acid amounts to about ten million pounds yearly, while the enormous soda industry probably has a value of somewhat similar dimensions.

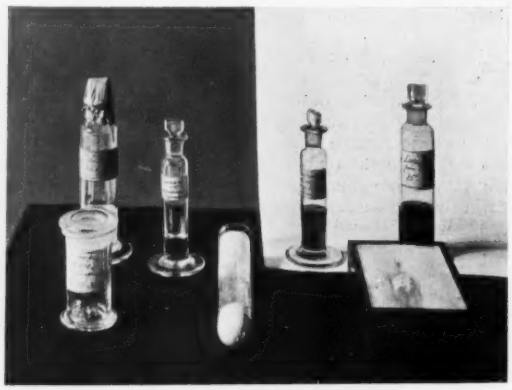


FIGURE 29.

Sir William Tilden's historic samples of Isoprene and Synthetic Rubber.

Yet, at the present time, crude rubber is annually produced of a value reaching the enormous total of thirty-four million pounds, and were we to add up the value of all manufactured rubber goods we would arrive at figures far exceeding those given for crude rubber, and running into some hundreds of millions of pounds. Huge as these figures are, there is no doubt that the demand for rubber far exceeds the supply, and for this reason the price paid for it considerably exceeds its cost of production. The rubber industry is a modern one. From small beginnings it has grown into a vast industry in which more than a hundred millions of capital are invested and in which hundreds of thousands of workmen all over the world find lucrative employment.

How recent is the growth of this industry may be gauged by the fact that in 1830 only twenty-five tons of rubber were exported from America, a quantity which had increased to seven hundred and fifty tons by 1850, and one thousand five hundred tons by 1870, against eighty-eight thousand tons now produced from all sources, and representing an annual value of thirty-four million pounds: this great change having occurred well within the lifetime of a single man. Within the last ten years no less than seventy million pounds have been invested in rubber plantations, and over twelve thousand tons of plantation rubber are now produced annually.

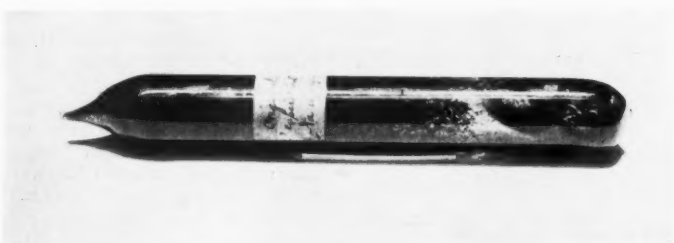


FIGURE 30.

Dr. Matthews' first tube of Synthetic Rubber.

The selling price of rubber has fluctuated enormously. In 1908 it once sank to two shillings and ninepence per pound, while in 1910 speculators actually ran it up to the fabulous price of twelve shillings and sixpence per pound, and many were the fortunes made and lost over rubber in that year, which recalls to mind the times of Priestly, who in 1770 could only purchase it at the rate of £16 per pound. At the present time good Para rubber sells

* See also an interesting article in "KNOWLEDGE" March, 1912, by Mr. Stanley Redgrove. The reader who wishes for a full account of the technical literature, and the chief patents relating to synthetic rubber, will find them fully discussed in my recent book "Industrial and Manufacturing Chemistry, Organic," published by Crosby, Lockwood & Son, London. 21/- net.

at from four shillings to five shillings a pound. Natural rubber could probably be produced profitably at as low a price as one shilling.

Naturally, a product of such value did not escape

FIGURE 31.

Dr. Otto Hehner testing Messrs. Strange & Graham's process for the production of fusel oils from starch.

the attention of the chemist, and numerous attempts have been made to produce rubber artificially, although until quite recently with no commercial success. The synthetic production of rubber, in fact, is a problem of extreme difficulty. Indeed, so complex that no one individual could hope to get over the difficulties; and it was only when chemists banded themselves together and began to work coöperatively with this object in view that any success was obtained.

To mention some of the difficulties, isoprene—the volatile hydrocarbon from which synthetic rubber was first obtained—is a liquid so volatile that it has only to be poured from one glass to another a few times before it all disappears in invisible vapour; it could at first only be produced by imperfect methods, and the yield was so bad that Kondakow could only obtain ten grammes, while Ipatjew only managed to make five grammes and Euler not two grammes! Before much progress could be made, methods had to be laboriously worked out for obtaining it in quantity. The chemists employed by the great German firm, Fr. Bayer & Co., of Elberfeld, endeavoured to obtain isoprene from coal-tar products in no less than fifty distinct ways, and all these ways failed except one! Indeed, until the chemical constitution of rubber had been worked out with a tolerable degree of certainty, its synthetic production commercially was scarcely realisable; the recently discovered methods of producing synthetic rubber by a chain of processes from maize, other cereals, potatoes or petroleum has been an immensely laborious task, requiring years of work and a large group of investigators. For any single man to have attempted it would have been hopeless.

An Englishman, Greville Williams, seems to have been the first to produce anything resembling rubber from isoprene nearly fifty-two years ago (in 1860); next, in 1875, Bouchardat, in France, definitely found that isoprene could be converted into rubber. In 1882, 1884 and 1892, Sir William A. Tilden (Figure 33) worked out the problem much further, and finally showed that synthetic rubber could be vulcanised like ordinary rubber. A large number of investigators have since worked at the problem, amongst whom should be mentioned Kondakow, Wallach, Mariutza, Weber, Thiele and many others. Kondakow especially, a Russian by birth, made many valuable observations.

About 1903, Professor Carl Harries (Figure 34), of Kiel University, began his epoch-making work on rubber, and in 1904 it was in full swing. The present writer was at that time studying at Kiel University and well remembers how Professor Harries installed electrical apparatus for producing ozone in quantity in some of the rooms, while everywhere danger notices were posted up "Dangerous to Life—Do not Touch," evidently to prevent inquisitive students from electrocuting themselves with the powerful high tension currents or blowing themselves up with the explosive ozonides which at that time he was producing in quantity.

Professor Harries is in many ways an interesting personality. He is reputed to be a man of enormous wealth, and only a few years ago he bought the Kaiser's famous racing yacht, the "Meteor"; he is

FIGURE 32.

Tubes containing Isoprene polymerising to rubber in Messrs. Strange & Graham's laboratory.

a well-known figure in German aristocratic circles. At the present time he, it is believed, is working in conjunction with some of the world-famous German chemical firms with the object of producing synthetic rubber commercially.

Harries' work was really epoch-making in every way. He indicated the probable constitution of rubber, reducing it to a simple formula; he showed how to prove chemically whether a substance was a true rubber or not, and indirectly his researches drew the attention of the chemical world to the enormous prizes to be won by the successful synthetic production of rubber. The stimulus produced by Harries' work, coupled with the high price of natural rubber, soon reflected itself in industrial chemical circles, and from 1907 onwards the patent literature bears witness to the extraordinary activity reigning in this department of chemistry.

Among the large continental firms which took part in the race were Fr. Bayer & Co., of Elberfeld, Germany, the Badische Aniline und Soda Fabrik, of Ludwigshafen, and Messrs. Schering, of Berlin. A photograph of Dr. Fritz Hofmann, who directed the work of the chemists of Fr. Bayer & Co., is shown in Figure 35.

Meanwhile in England the firm of Messrs. Strange and Graham united with a number of chemists of note with a view to produce synthetic rubber, and so the "Synthetic Products Co." of London came into existence. No less than fifteen chemists and bacteriologists were thus united at work on the problem. Foremost among these chemists must be mentioned Dr. F. E. Matthews (Figure 36), of the firm of Strange & Graham, who suggested the fusel oil route for the manufacture of isoprene and who was the first to discover and patent the sodium process of polymerising isoprene quantitatively into rubber, thereby making possible the commercial manufacture of synthetic rubber.

Mr. E. Halford Strange (Figure 37), head of the firm of Strange & Graham, organised the work of the group and brought into existence the company; Professor W. H. Perkin, junr., F.R.S. (Figure 38), Professor of Chemistry at Manchester University, with his two assistants Mr. Harold Davies and Dr. Weizmann, perfected the chemical processes employed in producing isoprene. Professor Perkin is the son of the famous Sir William Perkin, who brought into existence the aniline dye industry, and made a fortune out of it, although subsequently the colour industry went over into German hands.

Professor Perkin, who has produced an enormous quantity of research work of the highest quality in pure chemistry, has evidently inherited the practical abilities of his father; for he, a few years ago, invented the "non-flam" process for permanently fireproofing cotton goods.

Professor A. Fernbach (Figure 39), of the Pasteur Institute, succeeded in producing acetone and fusel oils cheaply by a process of fermentation from cereals, thereby producing the raw material for the manufacture of synthetic rubber.

Later, the group was joined by Sir William Ramsay (Figure 41), the famous discover of Argon, Helium and other inert atmospheric gases; it will be recollected that Sir William Ramsay quite recently resigned his professorship of chemistry at University College, London, about the same time that the company was formed.

Sir W. A. Tilden (Figure 33) also joined the company as a consulting chemist. It will be recollected that Sir William Tilden nearly thirty years ago had performed some epoch-making work on isoprene, and the formation of synthetic rubber from it.

Before we can give an account of the chemical processes for producing synthetic rubber commercially, we must explain its chemical constitution.

The net result of a vast amount of research work performed by various investigators, has been to show that when certain unsaturated hydrocarbons containing the grouping :C:C.C:C: are allowed to polymerise (*i.e.*, condense into more complicated bodies) they form a series of caoutchoucs or rubbers which possess many of the properties of the best sorts of natural rubber, including the power of vulcanising. Natural rubber is the rubber produced by the polymerisation of one particular hydrocarbon called *isoprene*; but the chemical sisters and brothers, so to speak, of isoprene all produce rubbers of different sorts, some of them with new and valuable properties for special purposes.

The hydrocarbons from which technical synthetic rubber have been formed are:—

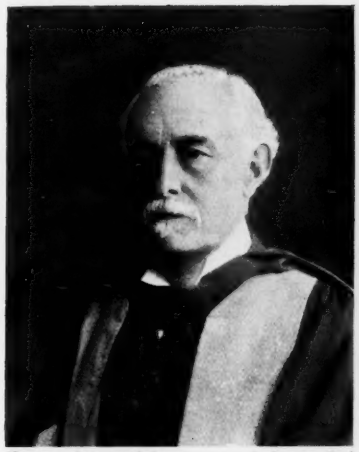
Butadiene (Erythrene, Divinyl), $CH_2=CH-CH=CH_2$.

β-Methyl butadiene (*isoprene*, methyl divinyl), $CH_2=C(CH_3)-CH=CH_2$.

β-γ-Dimethyl butadiene (di-isopropylene, dipropylene), $CH_2=C(CH_3)-C(CH_3)=CH_2$.

The first substance is at ordinary temperatures a gas, but readily condenseson cooling to a volatile liquid. The other two substances are volatile

$CH_2=CH-CH=CH_2$ $CH_2=CH-CH=CH_2$ Butadiene.	⟶	$\left(\begin{matrix}CH_2-CH=CH-CH_2\\ \quad\quad\quad\



From a photograph by *Lafayette, Ltd.*

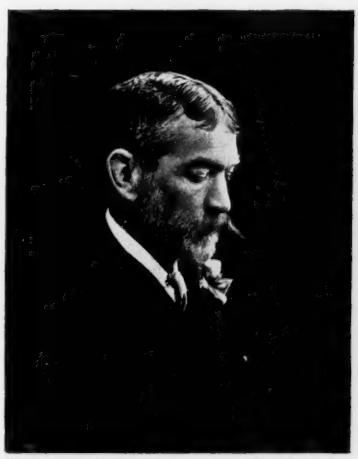
FIGURE 33.
Sir William A. Tilden.

From a photograph by *F. Urbahns.*

FIGURE 34.
Professor Carl Harries.

From a photograph by *Herrmann & Klein.*

FIGURE 35.
Dr. Fritz Hofmann.



From a photograph by *Speaight, Ltd.*

FIGURE 36.
Dr. F. E. Matthews.

From a photograph by *Hazel.*

FIGURE 37.
Mr. E. Halford Strange.

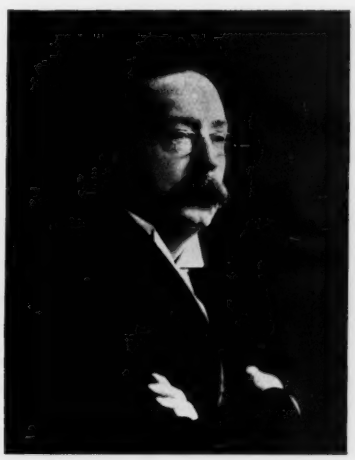


FIGURE 38.
Professor W. H. Perkin, Junr.

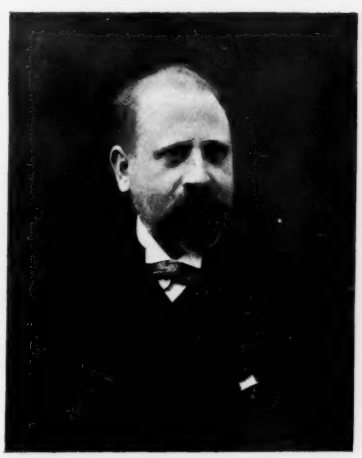


FIGURE 39.
Professor A. Fernbach.

From a photograph by *Lafayette, Ltd.*

FIGURE 40.
Mr. Charles A. Pim.

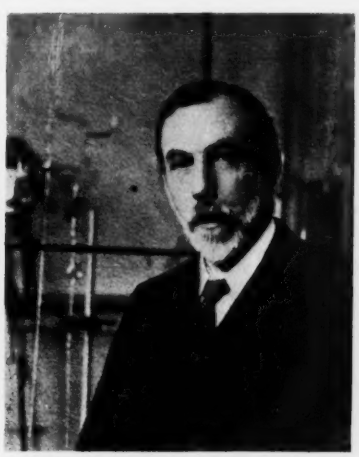


FIGURE 41.
Sir William Ramsay.

XUM

colourless liquids, boiling at 36°C and 71°C respectively. Higher members of the series are also known.

The polymerisation* may be regarded as taking place as shown in Table 6.

And, in general, a rubber derived from a homologue of butadiene, such as $CH_2=CX-CY=CH_2$, would produce rubbers of the formulae :—

$$\left(\begin{matrix}CH_2-CX=CY-CH_2\\ |\\ CH_2-CX=CY-CH_2\end{matrix}\right)_x \quad \text{and} \quad \left(\begin{matrix}CH_2-CX=CY-CH_2\\ |\qquad\qquad |\\ CH_2-CY=CX-CH_2\end{matrix}\right)_x$$

Once the hydrocarbons butadiene or isoprene are obtained, it is the simplest thing in the world to turn them into rubber.

All that has to be done is to introduce into the mobile liquids a small amount (five per cent. or less) of thin sodium wire and warm gently for some hours or days, when the products will change from liquids into solid masses of rubber. Figure 32 shows the process being carried out on the small scale. The sodium acts "catalytically" *i.e.*, it is not changed by the process and may be recovered afterwards and again utilised. It induces change without itself changing. Simple as this process seems, it took years of research to discover it, and then it seems to have been discovered almost simultaneously and independently by Dr. Matthews and Professor Carl Harries. The English investigator, however, owing to a priority of discovery of only about three months, succeeded in securing the patent world-rights. The discovery was alighted on almost as an accident. It occurred to Dr. Matthews that it would be of interest to study the action of sodium upon isoprene.

He, therefore, sealed up some isoprene with sodium in the tube shown in Figure 30 and set it aside in July, 1910. In the month of August, during a holiday, he was compelled suddenly to return to London, and on looking at his tube found that the liquid isoprene had now become viscid and contained a proportion of a remarkably good variety of rubber. The tube was again set aside, and in September was found to contain a solid mass of amber-coloured rubber. The patent was applied for on October 25th, 1910, only three months before the German application.

Before this time other methods were known of polymerising isoprene, notably the simple process of heating alone, but none of these methods can compare either in rapidity or certainty with the sodium method. Fr. Bayer & Co., of Elberfeld, simply heat under pressure, which certainly polymerises the isoprene. To show what an important advance this represents I will quote the words of Dr. Fritz Hofmann (who directed the research work on rubber for the German firm of Fr. Bayer & Co.), as published in his Freiburg address a few weeks before the publication of the sodium process. He says :—

"The obtaining of isoprene in quantity did not end our troubles, on the contrary, they now began in earnest, for now arose the problem of converting this benzine-like liquid into the tough, elastic, and resistant colloid known as rubber.

"At first sight nothing seemed simpler; for do we not read in Beilstein's Chemistry that 'isoprene is converted into rubber by treating with hydrochloric acid'? All we had to do then, was to add some hydrochloric acid to our isoprene; this we did, but alas! not a trace of rubber did we obtain, merely an oily chloride.

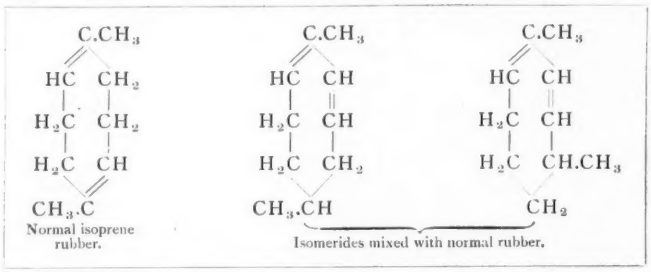
"Next we tried the action of light, which Wallach has shown to turn isoprene into a rubber-like substance. But such experiments require much patience when one is waiting for synthetic rubber, and at last got on our nerves: for after standing one and a half years in the light our isoprene had only turned into a fluid of the consistency of a thin syrup—evidently a perfectly useless technical process. So that now after months of experimenting we had obtained no useful result. In desperation we next tried acting on our poor isoprene with every possible and impossible chemical and physical influence in order to induce it to polymerise—but to our sorrow it obstinately refused to thicken !"

In fact, such great difficulties were experienced by German experimentalists in causing isoprene to thicken into rubber, that we actually find Professor Carl Harries in 1907, and even in 1910, doubting whether Tilden ever really obtained rubber from isoprene. But like many eminent scientific men Professor Harries is nothing if not a critical doubter.

So that the mere fact that he doubted whether

* As a matter of fact the polymerisation is a much more complex matter than this. Thus sticky or liquid lower polymerides are first formed, and the final polymerisation product is formed gradually by further condensation. Also Harries has shown (*Annalen*, **383**, 157-229) that different rubbers are obtained by using different polymerisation agents, *e.g.*, when butadiene is polymerised by heating alone or with acetic anhydride, it yields a "normal butadiene rubber," $(C_8H_{12})_n$, while when polymerisation is effected by sodium wire it yields quite a different rubber, called "sodium butadiene rubber." In a similar manner several isomeric rubbers are obtained by polymerising isoprene and dimethyl butadiene respectively. Thus, for isoprene rubber (natural rubber) Harries suggests (*Annalen*, **383**, page 187) the presence of three isomerides, which have the double linkage in a different position, as shown in Table 7.

TABLE 7.



Moreover, each of these isomerides may have several stereoisomerides. It will be seen that according to Harries' views the basis of rubber is the hydrocarbon cyclopentadiene (1 : 5) which contains a ring of eight carbon atoms:—

$$\begin{matrix}CH_2-CH=CH-CH_2\\ |\qquad\qquad |\\ CH_2-CH=CH-CH_2\end{matrix}$$

Pickles (*Jour. Chem. Soc.*, 1910) and Ostromisslensky (*Jour. Russ. Phys. Chem. Soc.*, 1912, 44, 204-244), suggest rings containing more than eight carbon atoms.

synthetic rubber had ever been obtained by Tilden, years before he had himself begun to experiment with this object, need not cause much surprise; more especially as all organic chemists look with grave suspicion on the labours of their fellow-workers.

However, Figure 29 will set the matter at rest; for therein is shown a photograph of Sir William Tilden's actual sample of synthetic rubber, which was obtained by the complete polymerisation of isoprene obtained by him no less than thirty years ago. The liquid isoprene had taken about twenty years to spontaneously solidify into rubber of good quality! This fact settles all argument about the matter, and there are still a great many people who distinctly remember him showing a sample of synthetic rubber, at a meeting of the Birmingham Philosophical Society on May 18th, 1892, the paper being published in the *Chemical News*, Vol. LXV., page 265 (1892).

After the foregoing remarks it will be seen that the commercially successful production of synthetic rubber depends entirely upon the possibility of producing cheaply the hydrocarbons, butadiene and isoprene — for both yield excellent rubbers.

It must be obvious that the raw materials we start with must not only be very cheap but must also be obtainable in practically unlimited quantity, if we are to produce a synthetic rubber capable of competing in any way with natural rubber.

Among the raw materials which have been suggested as a starting point may be mentioned:—

(1) Coal Tar. (2) Carbohydrates such as starch, sugar or wood. (3) Petroleum. (4) Turpentine oils.

We will deal with methods of obtaining isoprene or butadiene from these sources, taking each in turn. Dr. Fritz Hofmann, of the firm of Fr. Bayer, of Elberfeld, chose coal-tar as his starting point, and worked out a method of producing both isoprene and butadiene in quantity from this substance.

To produce butadiene, first of all *phenol* is isolated from coal-tar and then is converted by the following series of operations into butadiene. (See Table 8.)

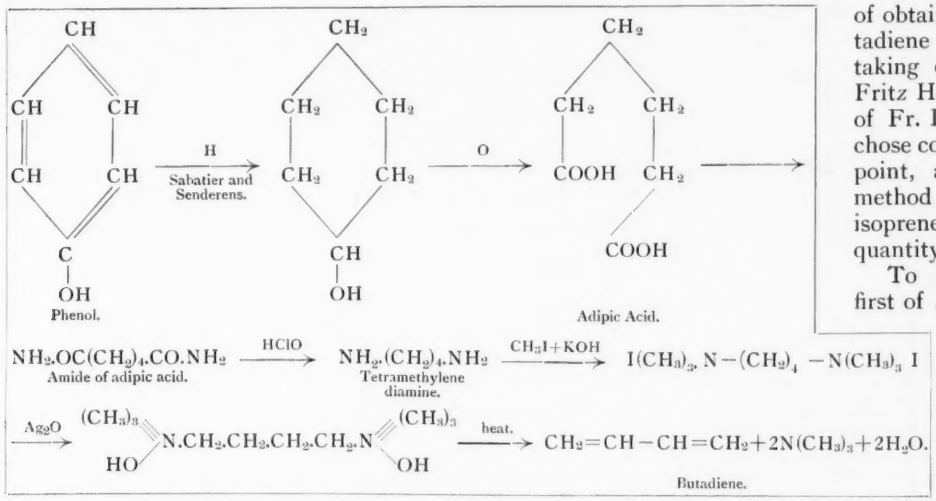


TABLE 8.

If, however, isoprene is required, it also is obtained from coal tar by isolating paracresol from it and then treating it to the series of reactions shewn in Table 9.

The β-Methyltetramethylene diamine thus produced is converted into isoprene by heating it with caustic potash, water, methyl alcohol, and methyl chloride, CH_3Cl, in an autoclave for twelve hours at 100° C., whereby the compound $Cl(CH_3)_3N.CH_2.CH(CH_3).CH_2CH_2.N(CH_3)_3Cl$ is produced. This

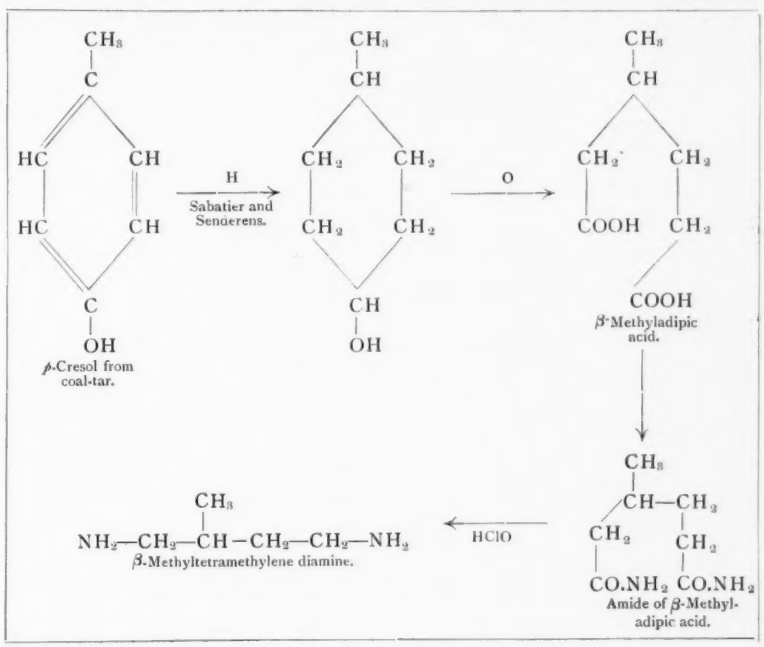
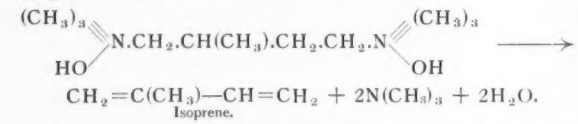


TABLE 9.

is converted into the base by replacing the Cl with OH by treating with silver oxide in the usual manner. The base, when distilled, breaks up into isoprene, thus



$$(CH_3)_3 \quad (CH_3)_3$$
$$HO\!>\!N.CH_2.CH(CH_3).CH_2.CH_2.N\!<\!OH \longrightarrow$$
$$CH_2{=}C(CH_3){-}CH{=}CH_2 + 2N(CH_3)_3 + 2H_2O.$$
Isoprene.

Homologues of isoprene may be produced in a similar manner.

By this paracresol method Hofmann produced *gallons* of isoprene, which was converted into rubber by polymerising by heating, and the rubber thus obtained was made into a motor-car tyre. One driving wheel of a motor-car was fitted with a tyre made of the best natural Para rubber (the best natural rubber known), and the other with this synthetic rubber; after six months' hard wear the Para tyre was badly worn, while the synthetic tyre was practically untouched—a conclusive proof of what can be done with synthetic rubber.

Quite recently (see *The Daily Mail*, September 11th, 1912,) in New York, two excellent specimens of synthetic rubber tyres, one a heavy five-and-a-half-inch and the other a four-inch tyre, were exhibited before a gathering of the world's chemists, by Fr. Bayer & Co.

(To be continued.)

NOTICES.

SECOND-HAND APPARATUS.—A very useful catalogue of second-hand apparatus and accessories has been issued by Messrs. H. F. Angus & Company, of 83, Wigmore Street, London. It specially deals with microscope stands, objectives, and eye-pieces by all the well-known makers. There are also lists of accessories, and of other instruments, such as telescopes, field-glasses, spectroscopes, and photographic lenses. It is practically certain that if there were not facilities for the obtaining of apparatus at a cheap rate many useful experiments would remain unmade, and it is a great advantage to workers that Messrs. Angus will give a written guarantee that any second-hand instrument which they sell has been tested and adjusted so that it will work as well as ever it did.

MESSRS. W. WATSON & SONS, LTD.—We have pleasure in announcing that Messrs. W. Watson & Sons have moved their electro-medical department from their establishment in High Holborn (which they have occupied for more than fifty years) to their new premises at 184, Great Portland Street, W., where, owing to the greater scope, this section of their business can now be carried on more advantageously than hitherto. For not only are there show-rooms for the display of electro-medical apparatus in every branch, but a testing laboratory has been provided where all the appliances will be carefully examined and checked on their receipt from the works at High Barnet before they are despatched to customers.

LANTERN SLIDE GALLERY.—Mr. J. H. Steward has opened at 406, Strand, a new lantern slide gallery, wherein can be seen at any moment two thousand slides, illuminated by electric light. Here will be found a good selection of slides of scientific interest, in addition to full series of photographic views of excellent quality, both plain and coloured, from all parts of the world. We noted specially a fine series of astronomical slides, produced by the Woodburygravure process. We welcome this addition to the very small number of lantern slide galleries in London.

NOTES ON NEW BOOKS.—From Messrs. Macmillan and Company comes an illustrated list with descriptive notes of their new and forthcoming books. The short paragraphs have advantages in some ways over reviews, because the publisher can say in them exactly what he wants his prospective readers to know about the book.

THE ROYAL INSTITUTION.—The following are the Lecture arrangements at the Royal Institution before Easter:—Professor Sir James Dewar, a Christmas Course of Six Experimentally Illustrated Lectures, adapted to a Juvenile Auditory: 1, Alchemy; 2, Atoms; 3, Light; 4, Clouds; 5, Meteorites; 6, Frozen Worlds. Professor William Bateson, Six Lectures on "The Heredity of Sex and some Cognate Problems." Professor H. H. Turner, Three Lectures on the Movements of the Stars: 1, "The Nebular Hypothesis"; 2, "The Stars and their Movements"; 3, "Our Greater System." Mr. Seton Gordon, Two Lectures on "Birds of the Hill Country." Professor B. Hopkinson, Two Lectures on "Recent Research on the Gas Engine." Sir Sidney Lee, Three Lectures on "The Dawn of Empire in Shakespeare's Era." Mr. W. B. Hardy, Two Lectures on "Surface Energy." Dr. H. Walford Davies, Three Lectures on Aspects of Harmony: 1, "Chord Progression"; 2, "Added Dissonance"; 3, "The New Whole Tone Chord and its Predecessors." Professor Sir J. J. Thomson, Six Lectures on "The Properties and Constitution of the Atom." The Friday Evening Meetings will commence on January 17th, when Professor Sir J. J. Thomson will deliver a Discourse on "Further Applications of the Method of Positive Rays." Succeeding Discourses will be given by Professor J. O. Arnold, Mr. George M. Trevelyan, Sir John Murray, Professor Andrew Gray, Mr. Spencer V. Pickering, Mr. C. T. R. Wilson, Professor the Hon. R. J. Strutt, and Mr. A. E. H. Tutton.

CLASSES IN PHOTOGRAPHY.—Mr. Edgar Senior's work at the following various educational centres begins on the dates set forth below.

Battersea Polytechnic.—Tuesday, January 14th.
South Western Polytechnic, Manresa Road, Chelsea.—Monday, January 13th.
The London Central Y.M.C.A., Tottenham Court Road.—Friday, January 10th.

LANTERN SLIDES.—The new catalogue of lantern slides issued by Messrs. Flatters & Garnett, Ltd., of Dover Street, Manchester, consists of one hundred and thirty-six pages, and many of the subjects in the list are from negatives illustrating natural history and cannot be obtained elsewhere; such, for instance, as the series of British birds, nests and eggs by Mr. Stanley Crook, and the British Plant Associations photographed by Mr. W. B. Crump. We can give the highest praise to the specimen slides which Messrs. Flatters and Garnett have submitted to us for review. The bird-photographs are excellent, as are the plant studies, and all of them should prove extremely useful to lecturers who have not the opportunity of making their own slides, or who wish to fill up gaps in their series. Teachers, who as a rule are not blessed with large means, should be able to take advantage of the slides, as they are by no means expensive. The examples sent to us are contained in one of Messrs Flatters & Garnett's special mahogany dispatch boxes, which we commend to our readers, and which are described on the cover of the catalogue.

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